NAVAL POSTGRADUATE SCHOOL
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THESIS

AN ANALYST'S AND USER'S GUIDE TO THE PASSIVE
SONAR MODEL IN THE NAVAL WARFARE
INTERACTIVE SIMULATION SYSTEM

by

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An Analyst's and User's Guide to the Passive
Sonar Model in the Naval Warfare
Interactive Simulation System

by

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I. INTRODUCTION

For centuries, military organizations have resorted to wargaming in order to train personnel and to evaluate tactics. In the past, actual troops, game boards, dice, umpires, etc., have been used to carry out a wargame. The advance of high technology, and the progress in the study of probability and modeling, have made it possible to use computers to simulate warfare. The Naval Warfare Interactive Simulation System (NWISS) is one such wargame.

NWISS is an extremely valuable system which can be used for tactical training, for tactical analysis, or for developmental research in evaluating new weapons systems if used properly. It is most useful as a tactical trainer because the operator has control over the scenario inputs and therefore can control the interactions within the wargame, as well as the results. These interactions and results may not reflect exact "real world" conditions, but can be made to come very close, based on past experiences or knowledge of previous outcomes. When the limitations of the wargame are known and are taken into account, NWISS can be used quite successfully as a tactical trainer.

In analysis of tactics and in developmental research, the use of NWISS is somewhat more limited. The requirements

to obtain satisfactory results are more stringent in these cases. It is more important to have "real world" results because conclusions based on other than "real world" results could have grave consequences or at the very least be wasteful of time and money. Therefore, it is imperative that a system being used for tactical analysis or developmental research be verified and validated prior to being used to ensure that the models utilized are sufficiently realistic for the application at hand.

In the Naval Warfare Interactive Simulation System, the passive sonar model determines detection between two elements, the detecting platform, and the target. The detecting platform is any platform with passive sonar capability such as a surface ship utilizing hull mounted sonar, a submarine utilizing a towed array, or an antisubmarine warfare (ASW) aircraft capable of monitoring passive sonobuoys. The target is any seagoing platform which can be detected by passive sonar. In many cases, a detecting platform may also be a target.

The passive sonar model in NWISS operates using the Monte Carlo method. That is, a probability of detection is computed which is subsequently compared to a random number drawn from a uniform (0,1) distribution (a number uniformly distributed between 0 and 1). The results of this comparison answers the question, Is the target detected?

The detection probability is computed each game minute, for each of three acoustic elements, for each sensor-target pair in the game within the maximum sonar range specified for the game (typically 120 nautical miles). The three acoustic elements are:

    a) Narrowband frequency signature.

    b) Emissions from active sonar.

    c) Broadband noise.

The passive sonar model computes the detection probability for each of the three acoustic elements associated with the target's underwater acoustic signal as a function of target source level, sonar performance, underwater ambient noise, and underwater acoustic propagation loss.

The NWISS operator, or persons preparing the wargame, can use the documentation and methodology described in this thesis in several ways. Primarily it will allow the operator to understand the passive sonar model so that he may prepare the antisubmarine warfare portion of the game more effectively and more efficiently. It will provide a method of producing desired sonar performance based on the training requirement by adjusting parameters appropriately. It allows the operator to check for reasonable or unreasonable results of the passive sonar encounter and identify parameters which need to be changed if the results

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are unreasonable. It provides a method for determining the expected ranges of detection for a specific passive sonar encounter.

For the trainee, this documentation provides a comprehensive look at the fundamentals of passive sonar detection. It provides a review of the passive sonar equation and explains each of the parameters concisely. The trainee can use the method described to determine the expected range of detection in order to compute the mean detection range (MDR) and subsequently plan for optimum ASW coverage in a particular area, against a specific target.

The content of this thesis is arranged to give the reader the background necessary to understand the passive sonar model in NWISS and then apply that background knowledge. Chapter II discusses NWISS briefly, relating the basics of setting up a wargame. Chapter III introduces the passive sonar equation. Chapter IV is the heart of the thesis; it describes in detail the passive sonar model used in NWISS and its function in passive sonar detection. Chapter V provides a logical step by step explanation of the NWISS passive sonar detection process. Chapter VI introduces the figure of merit and how it can be applied. Chapter VII offers conclusions and recommendations, and Appendix A discusses the environment files.

II. NWISS

The Naval Warfare Interactive Simulation System is
supported by the Interim Battle Group Tactical Trainer/
Computer Support Facility (IBGTT/CSF) located at the Naval
Ocean Systems Center in San Diego, California. In June
1982, NWISS was designated by the CNO to be utilized for
battle group tactical training by Tactical Training Group
Pacific (TACTRAGRUPAC), and by Pacific Fleet Commands until
such time as the Enhanced Naval Warfare Gaming System
becomes available (approximately 1986).

TACTRAGRUPAC employs NWISS as part of its Staff Team
Tactical Training (STTT) course. STTT is a four week
course designed to provide Battle Group Commanders and their
staffs with the most up to date tactical training available.
Three days of the course are dedicated to using NWISS. The
Battle Group Commander participating in STTT selects a
scenario which will meet the training requirement of the
battle group. Once the scenario is selected and the orders-
of-battle identified, an NWISS game can be created.

In 1983, NWISS was installed at the Wargaming, Analysis,
and Research (WAR) Lab at the Naval Postgraduate School,
Monterey, California. There it is used to expose military
officers to the limitations and capabilities of computer

wargaming. NWISS is taught as part of a simulation and wargaming course offered to Operations Analysis, Antisubmarine Warfare, Command, Control and Communications, Electronic Warfare, Space Operations, and other curricula.

In order to prepare a game, the operator invokes three computer processes, BUILD, FORCE, and GAME. BUILD constructs a database which specifies the characteristics which define the types of ships, submarines, aircraft, shorebases, satellites, sensors, and weapons to be used during the game. FORCE specifies the force elements and initial scenario conditions to be used. GAME actually executes the scenario and responds to player inputs.

The BUILD process allows the operator to review the database characteristic files of all object types used in NWISS (ships, submarines, aircraft, etc.). BUILD also allows the operator to add, delete, or modify any characteristic parameters as deemed necessary. If a desired game object type is not included, BUILD can be used to specify the characteristics of new object types. Normally, BUILD will already have been used to create a file of game object types which could then be used for different scenarios.

The FORCE process provides the operator with the means for building a specific scenario into the game. This is accomplished by using the generic characteristic files in BUILD such as that of a ship class, and assigning a specific

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name to that ship. The FORCE process also allows for the input of initial position, course and speed of the forces, environmental sonar regions (see Appendix A), weather conditions, emcon plans, command and communications hierarchy, as well as other initial conditions. As with the BUILD process, FORCE allows the operator to review, add, delete, or modify entries as necessary.

The GAME process provides the interactive aspects of NWISS. It is invoked just prior to game start and it is within this process that the game is executed.

The dynamics of the game are created and maintained in an area of computer memory and in a file called the blackboard. The blackboard is a global area and maintains the status of all game objects as the game progresses. The blackboard contains such parameters as the speed of ships or subs, and the range between detecting platform and target. For a more detailed description of how to run NWISS, the reader is referred to the user's guides in the bibliography.

To provide for the various functions of the wargame the Naval Warfare Interactive Simulation System uses a variety of models. Most of these are designed to model the physical situations using mathematical equations and rely on the database characteristic files to provide the values for the variables. This thesis examines the passive sonar model in NWISS which uses the passive sonar equation to determine the probability of passive sonar detection.

III. THE PASSIVE SONAR EQUATION

NWISS uses the passive sonar equation in the passive
sonar model to compute signal excess and subsequently to
determine whether passive detection does or does not occur.
This chapter introduces the passive sonar equation and
provides the reader with a brief review of the fundamentals
of passive sonar detection. It also serves as a reference
for Chapter IV, which describes the passive sonar model of
NWISS and the parameters it employs.

The passive sonar equation is primarily a specialized
mathematical statement of the law of conservation of energy.
The equation provides a working relationship that ties
together the effects of the medium, the target, the
equipment, and the operator. In NWISS, the use of the
passive sonar equation serves an important practical
function, namely that of predicting passive sonar
performance.

In developing the passive sonar equation, the following
thought processes must be taken:

a) Consider that the target radiates a certain acoustic
energy intensity level. The intensity level of this
acoustic energy is a function of the frequency or
band of frequencies radiated. This radiated level
is called target source level (SL).

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b) As the acoustic signal radiates outwardly from the source the intensity level is diminished due to any of the following effects of the ocean environment: spreading, ray path bending, absorption, reflection, and scattering. This decrease in intensity is called transmission loss (TL). Hence, the signal arriving at the detecting sonar array is represented by the target source level minus the transmission loss, (SL − TL).

c) The sonar array is subject to the background noise in the ocean. Background noise can be divided into two categories, self-noise (SN) and ambient noise (AN). Self-noise is the parameter representing that part of the background noise due to the effects of the machinery noise of the detecting platform and of the hydrodynamic flow past the array hydrophones. Ambient noise represents that part of background noise due to the effects of the sea state, shipping, and biologics or any other elements that introduce sound into the ocean. Background noise level (NL) is usually measured by omnidirectional hydrophones. Directional sonar arrays, however, will discriminate against omnidirectional noise. The measure of the advantageous effect of the array directivity is called the directivity index (DI). Since

directivity decreases the effect of background noise, the actual background noise apparent to the sonar array is the noise level minus the directivity index (NL - DI).

d) Consider now the capability of the sonar array and the ability of the operator, to detect an arriving signal. The measurement of this capability is called the recognition differential (RD). Recognition differential is defined as the signal received minus the apparent noise level required in order that an operator can detect a target on 50 percent of those occasions for which a target presents itself. In terms of the previously discussed parameters, the recognition differential is:

$$RD = SL - TL - (NL - DI) \qquad (3-1)$$

which is the passive sonar equation.

By placing the range independent terms on one side of the passive sonar equation it becomes more meaningful and useful:

$$TL = SL - NL - RD + DI. \qquad (3-2)$$

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When a value for transmission loss is available, either through direct measurement or through prediction, a term known as signal excess can be computed:

$$SE = SL - NL - RD + DI - TL. \qquad (3-3)$$

By definition, there exists a 50 percent probability of detection when the transmission loss equals the right hand side of Equation 3-2. Hence, in that case, the signal excess equals zero.

If the signal excess is greater than zero, then the probability of detection is greater than 50 percent. If the signal excess is less than zero, the probability of detection is less than 50 percent. This relationship between the signal excess and probability of detection provides the basis for the use of Equation 3-3 in the passive sonar model of NWISS.

IV.   THE PASSIVE SONAR MODEL

To prepare an NWISS game in which antisubmarine warfare
is to be conducted, it is necessary to thoroughly understand
how the passive sonar model operates. The model utilizes a
representation of the passive sonar equation described in
Chapter III. It draws parameters from the blackboard, the
database characteristic files, and the environment file.
Familiarization with these parameters and how they are
incorporated into the passive sonar model enable the
operator to prepare the ASW portion of an NWISS game. For
the player, while a thorough understanding of the passive
sonar model is not required, familiarization would be
advantageous in the formulation of tactics.

The general passive sonar equation used by the passive
sonar model in NWISS is:

$$SE = SL - NL - RD + DI - TL \qquad\qquad (4-1)$$

where,

SE = Signal Excess

SL = Target Source Level

TL = Transmission Loss

NL = Noise Level

RD = Recognition Differential

DI = Receiver Directivity Index

The above listed parameters are all in units of decibels.
The passive sonar equation presented above is modified when
used in detecting broadband noise to account for a bandwidth
correction factor. This modification will be discussed
under the section "Detection of Broadband Noise". In
addition to modeling passive detection, the passive sonar
model used in NWISS contains algorithms to determine
submarine contact classification, and target motion
analysis.

The following discussion will examine the parameters
used by the passive sonar model with respect to each
acoustic element and how to locate them in their respective
data files.

A. DEFINITION OF PARAMETERS

The numerical data used by the passive sonar model is
drawn from the database characteristic files, the
environmental files, and the blackboard. The passive sonar
model converts all the information necessary into the
parameters used by the passive sonar equation to determine
signal excess.

There are advantages and disadvantages to the use of
tabled data as opposed to the use of equations to model the
various parameters. The advantage in using table data is
primarily that computer processing time is decreased,
however, in the NWISS passive sonar model the use of tabled

data gives the operator the flexibility to adjust the parameters to affect the results of a passive sonar encounter. A major disadvantage is that by using tabled data for the parameters, all of the factors that affect the parameters are not taken into account. For example, directivity index is a function of frequency as well as direction but the tabled value for directivity index is only a function of direction.

In the environment file, ambient noise is presented as a function of frequency only, while it is also affected by shipping, weather, depth of the sensor, and biologics. Narrowband frequency target source levels are tabled according to frequency only, however, the source level is also a function of target speed.

In using NWISS as a tactical trainer, the advantages outweigh the disadvantages. However, using NWISS for analysis or for developmental research, the operator must consider the deficiencies of using the table parameters. The results of any analytical work or research must be carefully studied to determine whether the deficiencies in parameters significantly affect the validity of the model.

1. Database Characteristic Files

The following elements which contribute to passive sonar detection have characteristic data files:

1) Ships/submarines

2) Sonar systems

3) Sonobuoys

a. Ships/Submarines

The characteristic data of ships and submarines is contained in a file titled "Ship Class Characteristics" in the BUILD process. Figures 4-1 and 4-2 show example characteristic data files of a ship and submarine respectively. The parameters in the files utilized by the passive sonar model are the terms BBN, NBN, and SONAR.

The line labeled BBN contains the broadband noise level of the ship or submarine specified. The data on this line represents the values of the target source level of the representative ship or sub when its broadband noise is considered for detection. There is one line labeled BBN which requires six data entries. The data is arranged from left to right corresponding to target speeds of 5 kts., 10 kts., 15 kts., 20 kts., 25 kts., and 30 kts., respectively.

The line labeled NBN contains the narrowband frequency of the specific ship or submarine followed by the target source level. There may be up to six lines labeled NBN, each one identifying a separate narrowband frequency and source level. The data in the NBN line is used when considering narrowband signature detection of the respective ship or submarine, and represents the target source level in the passive sonar equation.

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```
CLASS   SSHIP
CAT     SURF
TYPE    FF
VMAX        27
XSECT       31
HDG     GYRO
SPD     PTLOG
CLRNG       15
DTRNG       21
TRKS        75
BBN        128     140     144     163     160     165
NAV     SRN12
LCHRT        1
RECRT        1
WAVE        20
LACOM       20
LASEN       20
LAWPN       30
LAFLD        5
LASPD       10
LAAIR       10
RBOC         2      48
NBN         91     144
DECM    YES
BLIP    YES
RDESM   SPS10       75
RDESM   SPS40       90
RDESM   WLR1        70
RDESM   SLR12       50
RDESM   SPG53       80
RDESM   LN66        90
RDESM   MK115       60
RDESM   URD4        60
SONAR   PSON1
SONAR   ASON1
COMMS   UHF         80
COMMS   HF          80
COMMS   VHF        100
MISS    HRPON        4
BUOY    SSQ53   SONO    300
BUOY    SSQ47   SONO    200
WEAP    SSPRO   SAM       8
WEAP    G554    GUN     600
WEAP    MK46A   TORP     20
WEAP    ASROC   TORP     12
WEAP    MK46    TORP     22
AIR     SH2F         1

   . .                        .
```

Figure 4-1.   Database Characteristic File of a Ship

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```
CLASS   SSUB
CAT     NSUB
TYPE    SSGN
VMAX        22
XSECT       22
HDG     GYRO
SPD     PTLOG
CLRNG        6
DTRNG       10
TRKS        75
BBN        137    139    141    143    145    147
DRATE      250
KEEL        30
PSCOP       60
DR      SINS
OMEGA   LWSPT
NBN        300    145
NBN        585    139
RDESM   SNPTR       20
RDESM   BRKSP       60
SONAR   PSON2
SONAR   ASON2
COMMS   HF          90
COMMS   UHF         90
MISS    SSN7         8
NAV     NAVST
TORP    ET80        32
WIRES        3
```

Figure 4-2.   Database Characteristic File of a Submarine

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The line labeled SONAR specifies the particular sonar system used by the ship or submarine. Each line has only one entry, there may be as many as six SONAR lines, each identifying the available sonar systems for the particular ship or submarine of interest. This line serves as an index to the sonar characteristic data file described below.

b. Sonars

The characteristic data of sonar systems is contained in a file titled "Sonar Characteristics" in the BUILD process. Figures 4-3 and 4-4 show example characteristic data of an active sonar and a passive sonar, respectively. Since this thesis is concerned with the passive sonar system as the detecting sensor, all of the parameters listed with the exception of CFREQ in the passive sonar system characteristic data file are used by the passive sonar model. Because an active system is a source for passive detection, only the terms CFREQ and LEVEL in the active sonar characteristic file are of interest in considering passive sonar detection.

```
>NAME      ASON2
>CAT       AHULL
>CFREQ      3000
>LEVEL       240
MNFAL       4320
MNRPR       1440
MODE        DP
MODE        CZ
```

Figure 4-3.   Database Characteristic File of an
              Active Sonar System

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NAME	PSON1					
CAT	PHULL					
CFREQ	2000					
LFREQ	300					
HFREG	2500					
HZBW	8					
VERBW	45					
BRERR	2					
RD	-12					
DI00	21	21	21	21	21	21
DI60	21	21	21	21	21	21
DI120	21	21	21	10	0	-10
BBN	64	65	69	79	84	84
NBN1	300	300	300	300	300	300
NBN2	300	300	300	300	300	300
NBN3	300	300	300	300	300	300
NBN4	300	300	300	300	300	300
NBN5	300	300	300	300	300	300
NBN6	300	300	300	300	300	300
NBN7	300	300	300	300	300	300
NBN8	300	300	300	300	300	300
NBN9	300	300	300	300	300	300
NBN10	300	300	300	300	300	300
NBN11	73	77	77	80	82	300
NBN12	56	62	63	67	67	300
NBN13	46	53	54	59	62	300
NBN14	41	45	45	51	57	300
NBN15	39	41	43	51	57	300
NBN16	37	38	42	52	57	300
NBN17	36	37	41	51	57	300
NBN18	300	300	300	300	300	300
NBN19	300	300	300	300	300	300
NBN20	300	300	300	300	300	300

Figure 4-4.   Database Characteristic File of a Passive
Sonar

The lines labeled LFREQ and HFREQ define the low and high frequency limits of the system, respectively. There is one data entry for each line. The particular sonar system is capable of detecting frequencies which lie between the values specified by LFREQ and HFREQ inclusive.

The lines labeled HZBW and VERBW define the horizontal and vertical beamwidths of the system, respectively. Each line contains only one data entry. The sonar system considered is capable of detecting targets that lie in the volume defined by the angles specified by HZBW and VERBW.

The line labeled BRERR indicates the standard deviation used in reporting the bearing of the contact. The data is not used in the detection process.

The line labled RD defines the recognition differential of the system. There is one entry in this line, typically a negative number. The value of RD is used directly in the passive sonar equation to compute signal excess.

The lines labeled DI00, DI60, DI120, define the directivity index of the sonar system. Each line has six data entries which correspond to the target angle off the bow of the detecting platform. Each line covers a sixty degree sector of which each entry corresponds to ten degrees. The data entry specifies the value used for DI in the passive sonar equation.

The line labeled BBN in the sonar characteristic
data file defines the self noise of the system when it is
used in detecting broadband noise. There are six data
entries in the line corresponding to detecting platform
speed. Arranged from left to right, the entries define the
self noise of the system for speeds of 5 kts., 10 kts., 15
kts., 20 kts., 25 kts., and 30 kts., respectively. The
value specified by the data is used in the computation of
the noise level.

The lines labeled NBN1 through NBN20 define the
self noise of the system when it is detecting a narrowband
signature. Each line corresponds to one of the 20
frequencies listed in the environment file and shown in
Table 4-1. Lines NBN1 through NBN20 each have six entries
corresponding to the detecting platform speed, as with the
BBN line described in the previous paragraph.

TABLE 4-1

Frequencies Corresponding to Lines NBN1 Through NBN20

NBN1	10 Hz	NBN11	315 Hz
NBN2	15 Hz	NBN12	630 Hz
N3N3	20 Hz	NBN13	900 Hz
NBN4	30 Hz	NBN14	1250 Hz
NBN5	40 Hz	NBN15	1600 Hz
NBN6	60 Hz	NBN16	2000 Hz
NBN7	80 Hz	NBN17	2500 Hz
NBN8	100 Hz	NBN18	3500 Hz
NBN9	125 Hz	NBN19	5000 Hz
NBN10	250 Hz	NBN20	10000 Hz

c. Sonobuoys

The characteristic database describing sonobuoys
is contained in a file titled "Sonobuoy Characteristics" in
the BUILD process. Figure 4-5 shows the database
characteristic file of a sonobuoy. There are only three
lines included in the characteristic database file of
sonobuoys which are different from those in the "Sonar
Characteristic" described above: LIFE, MNFAL, and OMNI.
LIFE indicates the amount of time that the sonobuoy is
operational. MNFAL defines the mean failure rate, and OMNI
specifies whether the sonobuoy is omnidirectional.

2. Environment File

The environment file contributes three parameters to
the passive sonar detection process: Sonic layer depth,
ambient noise, and transmission loss. This section will
describe each of these three terms. For a more detailed
explanation of the environment files, see Appendix A.
Samples of environment files are also contained in
Appendix A.

The sonic layer depth is the first entry in the
environment file. It represents the depth at which the
sound speed gradient shifts from positive to negative
defining the floor of surface duct. It is the value
specified by the sonic layer depth that is used in
determining the source/receiver layer geometry. If the

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```
NAME    SONO1
CAT     PASS
LIFE      180
CFREQ     300
LFREG      10
HFREG    2400
HZBW       12
VRBW       20
BRERR       5
RD         -5
DIOO        2        2        2        2        2        2
DI60        2        2        2        2        2        2
DI120       2        2        2        2        2        2
MNFAL    1000
OMNI     NO
```

Figure 4-5.   Database Characteristic File of a Passive
              Sonobuoy

source (target) and the receiver (detecting platform)

are both shallower than the sonic layer depth, the

source/receiver layer geometry is said to be IN layer.   If

they are both deeper than the sonic layer depth, the

source/receiver layer geometry is said to be DEEP.   If the

source is deeper and the receiver is shallower than the

sonic layer depth or vice versa, the source/receiver layer

geometry is a CROSS layer one.

        The layer geometries correspond to the columns in

the transmission loss tables labeled IN, CROSS, and DEEP.

In the case of towed array sonars, the hydrophones are

modeled at a depth of 300 feet below the depth of the towing

platform. Hull mounted sonars are modeled at the depth of
the detecting platform. In order to avoid micro-management
of assets, sonobuoys were modeled with only one depth
setting, 300 feet. This factor also contributes to the
inflexibility of the NWISS passive sonar model in the
analysis or developmental research role.

The values for ambient noise are in the sixth line
of the environment file labeled Ambient Noise. There are 20
entries which correspond to the 20 frequencies in the
previous line. The frequency of interest being detected is
used to determine the value of ambient noise used in
calculating the noise level term in Equation 4-1. The value
of ambient noise is read directly below the frequency
nearest the frequency of interest, using the higher
frequency, if the frequency of interest is exactly between
two listed frequencies.

The transmission loss tables are labeled Propagation
Loss Data and make up about 85% of the environment file.
The data is tabled according to frequency, source/receiver
layer geometry, and range from the source to the receiver.
That is, there is a single value of transmission loss for
each of the 20 frequencies listed, for each of the three
possible source/receiver layer geometries, and for the
specific range between source and receiver from one to 120
nautical miles in 1 NM increments. To determine the value

of transmission loss used in Equation 4-1 refer to the propagation loss data table under the frequency nearest the frequency of interest, using the higher frequency, if the frequency of interest is exactly between two listed frequencies. In that table, select the column corresponding to the appropriate source/receiver layer geometry and read the value of the transmission loss across from the appropriate range.

Each parameter listed in the NWISS passive sonar equation has been described and their location within the NWISS architecture discussed. The following sections will describe the calculations involved in the detection of each acoustic element. Narrowband frequency signature detection will be discussed first, followed by detection of active sonar emissions, and broadband noise detection. The final section in this chapter will describe how the probability of detection is determined.

B. DETECTION OF NARROWBAND FREQUENCY SIGNATURE

The narrowband frequency signature of a potential passive sonar contact is due to the domination of the particular frequency or tonal in the noise radiated from the target. In NWISS a ship or submarine may be assigned up to six narrowband frequencies. The narrowband frequency used for a particular calculation of signal excess will be referred to as the narrowband frequency of interest.

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1. Target Source Level

The target source level (SL) is specified in the characteristic file of the target. It is located in a line labeled NBN (there may be as many as six lines labeled NBN). In the case of diesel submarines, the line labeled NBN applies when the submarine is submerged running on batteries, and the line labeled NBD applies when the submarine is snorkeling. The first number in the line is the narrowband frequency of interest. The second number is the target source level. Note that the target source level used in the passive sonar model for narrowband signature detection is solely a function of the narrowband frequency of interest, and not speed of the target.

2. Transmission Loss

The value of transmission loss (TL) is taken from the transmission loss tables of the environment file corresponding to the location of the detecting platform (See Appendix A for sample environment file). To determine the value of the transmission loss, enter the table corresponding to the frequency nearest the narrowband frequency of interest, using the higher frequency, if the narrowband frequency of interest is exactly between two tabled frequencies. Next, you identify the column corresponding to the appropriate source/receiver layer geometry, and read the value of transmission loss down the

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column, opposite the range. Transmission loss in the passive sonar model of NWISS, is a function of four elements: 1) detecting platform location, 2) frequency of interest, 3) source/receiver layer geometry, and 4) range from the target to the detecting platform.

3. Noise Level

The noise level (NL) is computed as the power sum of the ambient noise (AN) and the receiver self noise (SN), using the following equation:

$$NL = 10 \log [10^{(AN/10)} + 10^{(SN/10)}] \qquad (4-2)$$

Ambient noise is taken from the environment file corresponding to the location of the detecting platform. The value for ambient noise is located in the line labeled AMBIENT NOISE. To determine the ambient noise used to compute the signal excess, read the value directly beneath the frequency nearest the narrowband frequency of interest, using the higher frequency, if the narrowband frequency of interest is exactly between two listed frequencies.

Self noise is specified in the characteristic data file of the passive sonar system used by the detecting platform. The characteristic data file of the detecting platform identifies the passive sonar system in a line labeled SONAR. To locate the value of self noise in the

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sonar system characteristic data file, refer to the portion
of the file labeled NBN1 through NBN20. NBN1 through NBN20
correspond to the 20 frequencies described in Table 4-1 and
also found in the environment file. Find the line
corresponding to the frequency nearest the narrowband
frequency of interest, using the higher frequency, if the
narrowband frequency of interest is exactly between two
listed frequencies, and read the value of self noise from
the column corresponding to the speed nearest the speed of
the detecting platform. The columns correspond to speeds of
5 kts., 10 kts., 15 kts., 20 kts., 25 kts., and 30 kts.,
respectively reading from left to right. For sonobuoys and
for ships/submarines doing 0 kts., 1 kt., or 2 kts., the
self noise is zero.

Due to the nature of Equation 4-2 the value of the
noise level will never be less than the larger of ambient
noise and self noise, and will never be more than 3 dB
greater than the larger of the ambient noise and self noise.
The latter occurs when ambient noise equals self noise. The
former occurs when the difference between ambient noise and
self noise is more than 20 dB. In summary, the noise level
in NWISS is a function of three elements: 1) detecting
platform location, 2) frequency of interest, and 3)
detecting platform speed.

4. Directivity Index

Directivity Index (DI) is located in the characteristic data file of the passive sonar system used by the detecting platform. The sonar system is identified in the characteristic data file of the detecting platform in the line labeled SONAR. Directivity index is read from the lines in the sonar system characteristic data file labeled DI00, DI60, and DI120. Those lines include the values of directivity index corresponding to target angles off the bow of the detecting platform. DI00 contains values for target angles between 0 and +/- 59 degrees relative (the first column being 0 and +/- 9 degrees, second column being +/- 10 to +/- 19 degrees, etc.). Similarly, DI60 contains values for target angles between +/- 60 degrees and +/- 119 degrees relative. While DI120 contains the values for target angles between +/- 120 degrees and +/- 180 degrees relative. The directivity index used for calculating the signal excess in NWISS is a function of only the target angle off the bow of the detecting platform.

5. Recognition Differential

The recognition differential (RD) is located in the characteristic data file of the passive sonar system used by the detecting platform in the line labeled RD. The sonar system is identified in the characteristic data file of the detecting platform in a line labeled SONAR.

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C. DETECTION OF ACTIVE SONAR EMISSIONS

In the detection of active sonar emissions, the passive sonar model includes the signal output by underwater communications equipment as well as the acoustic signal of an active sonar "pinging". The frequency detected is the frequency of the underwater transmission or the center frequency of the active sonar system on the target.

The underwater communication equipment is identified from the target characteristic data file in a line labeled COMMS. The frequency of the transmitted signal is found in the characteristic data file of the underwater communication system specified in the line labeled FREQ. The active sonar system of the target is specified in the characteristic data file of the target in a line labeled SONAR. The center frequency of the active sonar acoustic signal is found in the characteristic data file of the active sonar system in the line labeled CFREQ. The applicable frequency will be referred to as the active emission frequency of interest.

1. Target Source Level

Target source level (SL) is specified in the characteristic data file of the active sonar system used by the target. The characteristic data file of the target identifies the active sonar system in a line labeled SONAR. The target source level is found in the characteristic data file of the active sonar system in the line labeled LEVEL.

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2. Transmission Loss

The value of transmission (TL) is taken from the transmission loss tables of the environment file corresponding to the location of the detecting platform. To determine the value of the transmission loss, enter the table corresponding to the frequency nearest the active emission frequency of interest, using the higher frequency, if the active emission frequency of interest is exactly between two tabled frequencies. Next, identify the column corresponding to the appropriate source/receiver geometry, and read the value of transmission loss down the column, opposite the range. In its application to the passive sonar model of NWISS, the transmission loss is a function of four elements: 1) detecting platform location, 2) frequency of interest, 3) source/receiver geometry, and 4) range from the target to the detecting platform.

3. Noise Level

The noise level (NL) in the case of detecting active emissions is computed in the same manner as in the narrowband signature detection. See "Noise Level" on page 33.

4. Directivity Index

Directivity index (DI) is located in the same way for detection of active emission as it is for detecting narrowband signature. See "Directivity Index" on page 35.

5. Recognition Differential

The procedure for locating the recognition differential (RD) is identical for all three acoustic elements. See "Recognition Differential" on page 35.

D. DETECTION OF BROADBAND NOISE

Broadband noise is that noise radiated from the target which has a continuous noise spectra. That is, the signal level is a continuous function of frequency as opposed to discontinuous as the case with narrowband signals. To detect broadband noise using the passive sonar model in NWISS a mean frequency is specified. That mean frequency will be referred to as the broadband noise frequency of interest. At the time of this writing, the broadband noise frequency of interest used in the NWISS passive sonar model is 2000 Hz.

Associated with the detection of broadband noise is the bandwidth correction to the passive sonar equation. The bandwidth in detecting broadband noise using the passive sonar model in NWISS is 500 Hz. The bandwidth correction applies to the target source level and to the detecting platform self noise. The correction is calculated using the following expression:

$$C = -10 \log W \qquad\qquad (4-3)$$

where,

C = bandwidth correction

W = bandwidth

Since the bandwidth in NWISS is fixed at 500 Hz, from
Equation 4-3 the correction is -27 dB. The passive sonar
equation modified for the detection of broadband noise is
then:

$$SE = SL - NL - RD + DI - TL - 27 \qquad (4-4)$$

The correction as applied to self noise will be covered in
the discussion of noise level.

1. Target Source Level

The target source level (SL) is located in the
characteristic data file of the target in the line labeled
BBN. In the case of a diesel submarine the line labeled BBN
applies to the submarine submerged operating on batteries.
If the submarine is surfaced and snorkeling the line labeled
BBD applies. The line is arranged corresponding to the
speed of the target, from left to right with target source
level values for 5 kts., 10 kts., 15 kts., 20 kts., 25 kts.,
and 30 kts., respectively. To obtain the target source
level used in the calculation of the signal excess, read the
entry corresponding to the speed nearest the target speed.
For a target doing 0 kts., 1 kt., or 2 kts., the target
source level is zero.

2. Transmission Loss

The procedure for locating the value of transmission
loss used in calculating the signal excess when detecting

broadband noise is identical to that used when detecting narrowband noise with one exception. Instead of using the narrowband frequency of interest use the broadband noise frequency of interest which is 2000 Hz.

3. Noise Level

To compute noise level in the case of broadband noise detection, the bandwidth correction must be taken into account. The equation used is:

$$NL = 10 \log [10^{(AN/10)} + 10^{((SN-27)/10)}] \quad (4-5)$$

Ambient noise and self noise are located in the same manner for broadband noise detection as for the other two acoustic elements. See "Noise Level" on page 33.

4. Directivity Index

The procedure for locating the directivity index (DI) in the case of detecting broadband noise is identical to that of when detecting narrowband signature. Refer to "Directivity Index" on page 35.

5. Recognition Differential

The procedure for locating the recognition differential when detecting broadband noise is identical to that when detecting narrowband signature. Refer to "Recognition Differential" on page 35.

E. DETERMINING THE PROBABILITY OF DETECTION

Once the passive sonar model computes the signal excess, it then converts it to a probability of detection. The probability of detecting a passive sonar contact is treated as a normal distribution with a mean equal to zero and standard deviation equal to 2 dB. A bell curve representation of signal excess is shown in Figure 4-6.
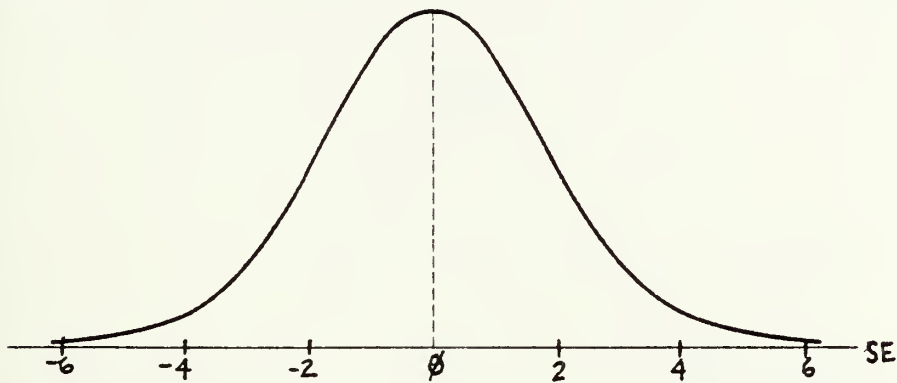
Figure 4-6.   Normal Curve Representation of Signal Excess

The signal excess is then converted to a standard normal Z score using the following equation:

$$Z = (SE - \mu)/\sigma \qquad\qquad (4-6)$$

where,

Z   = Standard normal Z score

SE = Signal excess

μ = Mean signal excess

σ = Standard deviation of the signal excess

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So that the Z score for the computed signal excess is:

$$Z = SE/2 \qquad (4-7)$$

The Z score is then converted to a probability of detection (P_d) from a table of cumulative standard normal distribution. Figure 4-7 shows the bell curve representation of the Z score mapped against the signal excess.
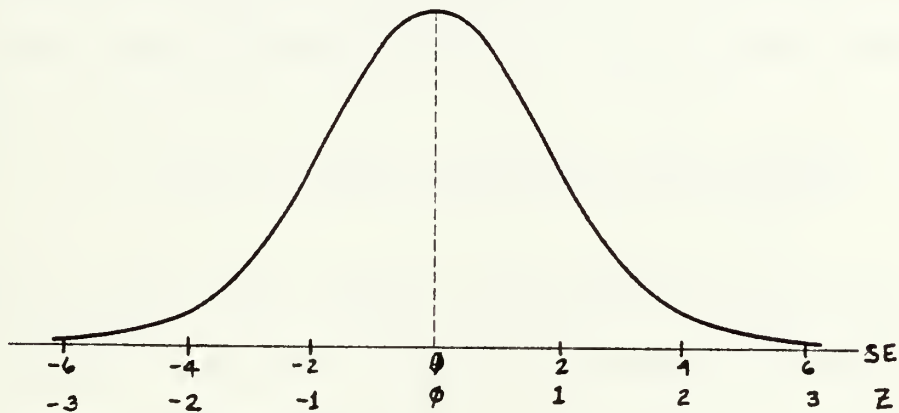
Figure 4-7. Normal Curve Representation of Z Score

The probability of detection is then tested against a random number to determine whether the target is detected or not detected. Using a pseudo-random number generator, the computer simulates drawing a number from the uniform zero to one distribution. If the $U(0,1)$ random number is less than the computed P_d, the target is detected, otherwise it is not detected. There are two cases in which no test between P_d

and a random number is performed. If the Z score is greater than or equal to 3.0 then a detection is made without testing against a random number. If the Z score is less than or equal to -3.0, there is also no test against a random number and there is no detection.

In addition, no detection is reported for each of the following cases:

a) The detecting sonar is a towed array and the platform employing the array has not maintained a steady course for a time equal to 0.02 times the array cable length divided by the platform speed:

$$t = (0.02 \times Cable\ Length)/Platform\ Speed \qquad (4-8)$$

b) The target true bearing is the same as the true bearing of another detected broadband source with a greater signal excess.

c) The frequency is the same as the frequency of another detected narrowband tonal, the true bearing of which is within one-half beamwidth of the source of this frequency, and the other source has a higher signal excess.

As shown in Figure 4-6, the test of P versus a random number applies only to signal excesses between -6.0 and 6.0. This is because of the choice of 2 dB for the standard

deviation of the signal excess. The standard deviation of 2 dB was chosen because it provided more consistent detections than a higher standard deviation and yet did not provide "cookie cutter" results using a lower standard deviation. The standard deviation controls the range window of detections.

As an example of converting a signal excess to a probability of detection, consider the following. Suppose the computed signal excess for a given passive sonar encounter is 3.74. Using Equation 4-7, the Z score is 1.87. From a table of cumulative standard normal distribution, a Z score of 1.87 represents a probability of detection of 0.9693. That is, for a signal excess of 3.74, the probability of detecting the target is 96.93 percent. Due to the symmetry of a normal distribution, a computed signal excess of -3.74 would yield a probability of detection of (1 - 0.9693) or 0.0307. Therefore, if the computed signal excess was -3.74, the probability of detecting the target is 3.07 percent.

V. THE DETECTION PROCESS

To perform the detection computations required, the
passive sonar model used in NWISS makes use of the standard
passive sonar equation. This is accomplished by retrieving
the independent variables to be used in the equation from
the game's various data files and simply performing an
algebraic summation resulting in the signal excess. There
is a logical sequence of steps that is followed in
determining whether or not a passive detection is made. A
flow diagram is provided to show the detection process. See
Figures 5-1 through 5-11.

The diagram outlines the detection process for only one
pair of opposing platforms. This process takes place within
NWISS each game minute and for all the possible combinations
of platforms with passive sonar capability versus non-own
force surface or submarine platforms that are involved in a
particular game scenario. The diagram is not a true
computer program flow diagram since it was not taken
directly from the source code of the passive sonar model but
it is a logically accurate representation of the source
code.

The objective of the passive sonar model is to determine
whether or not there is passive sonar contact in any of the
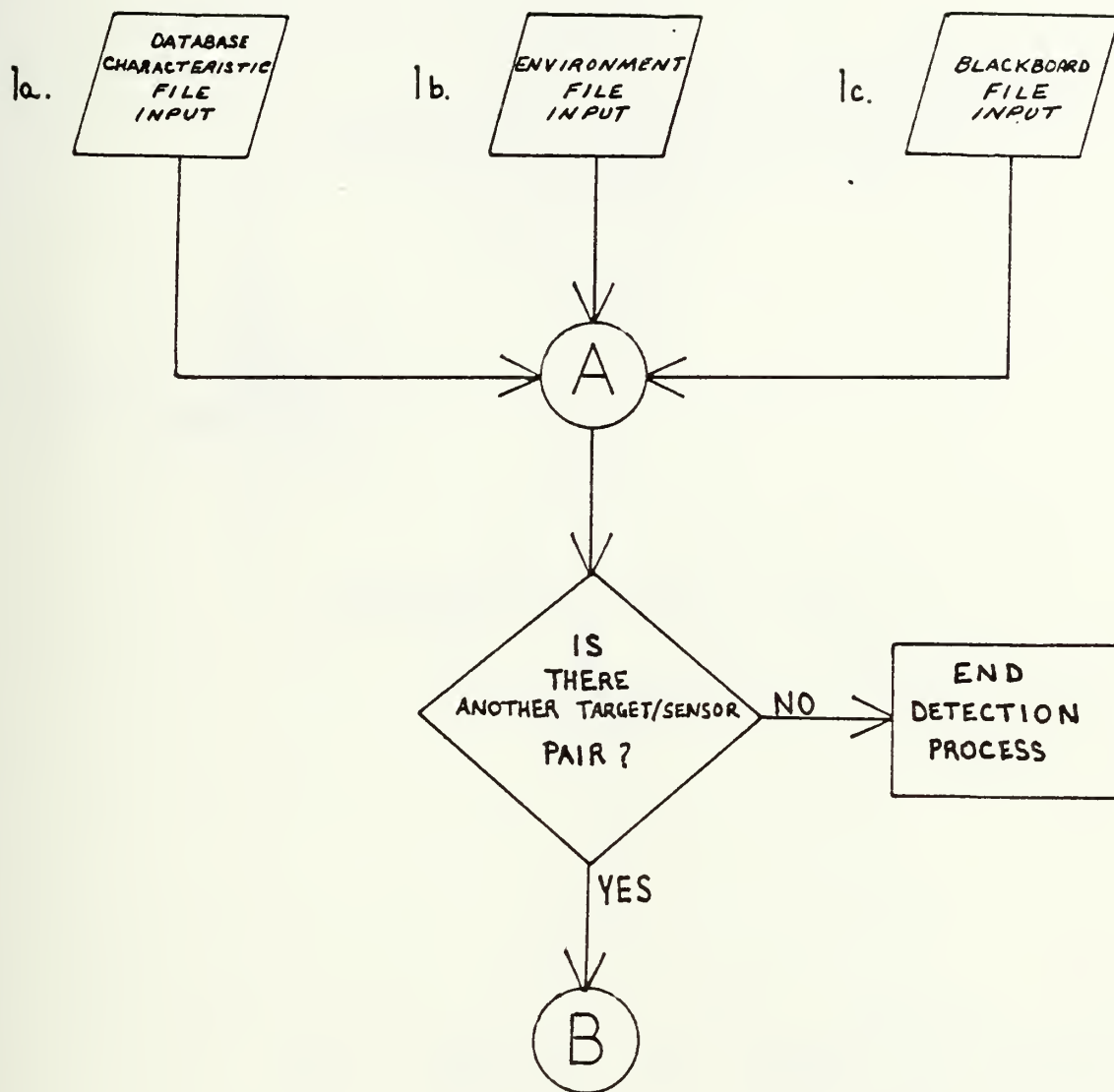
Figure 5-1. Steps 1a, 1b, and 1c

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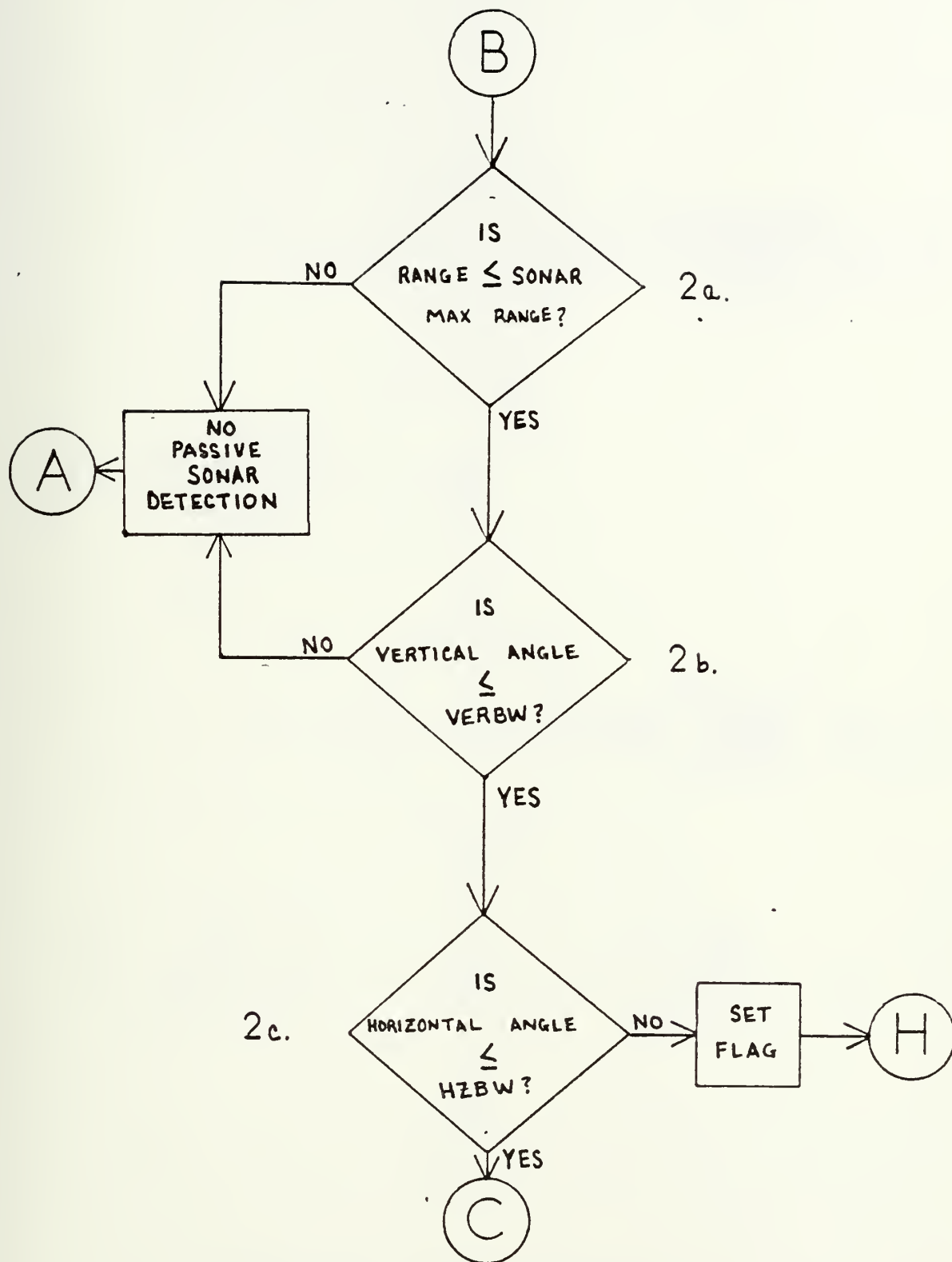
Figure 5-2.   Steps 2a, 2b, and 2c

47
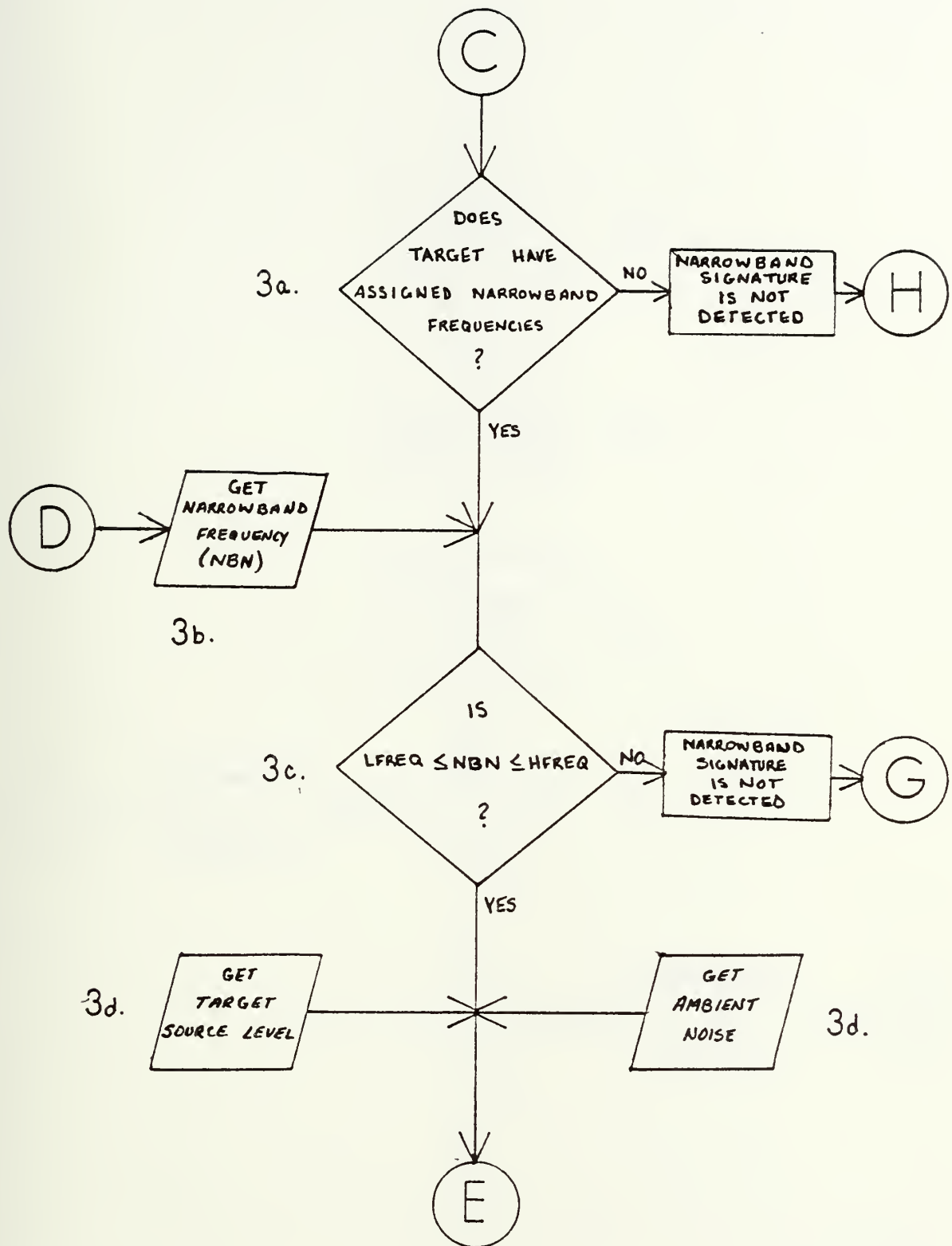
Figure 5-3.   Steps 3a through 3d

48
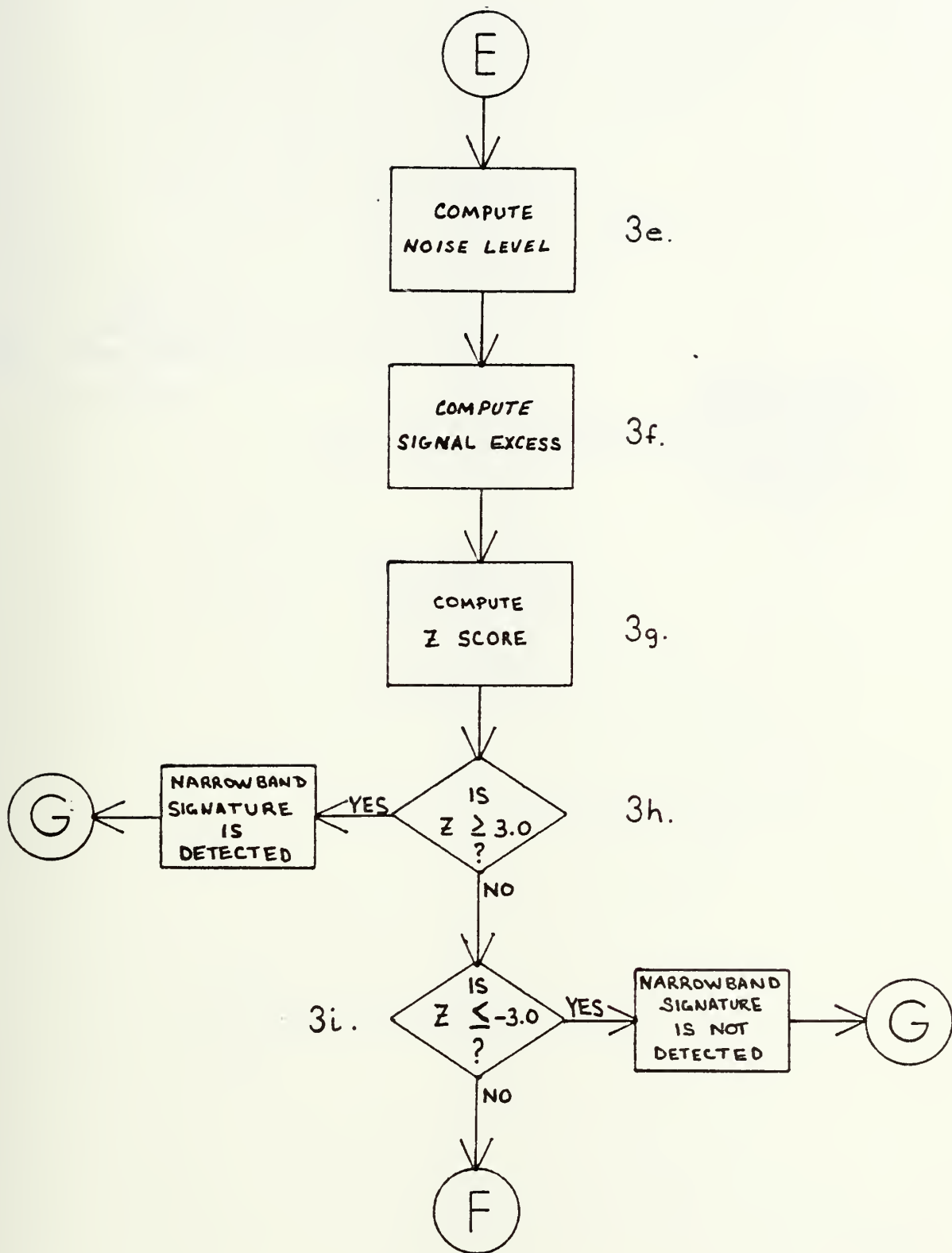
Figure 5-4. Steps 3e through 3i
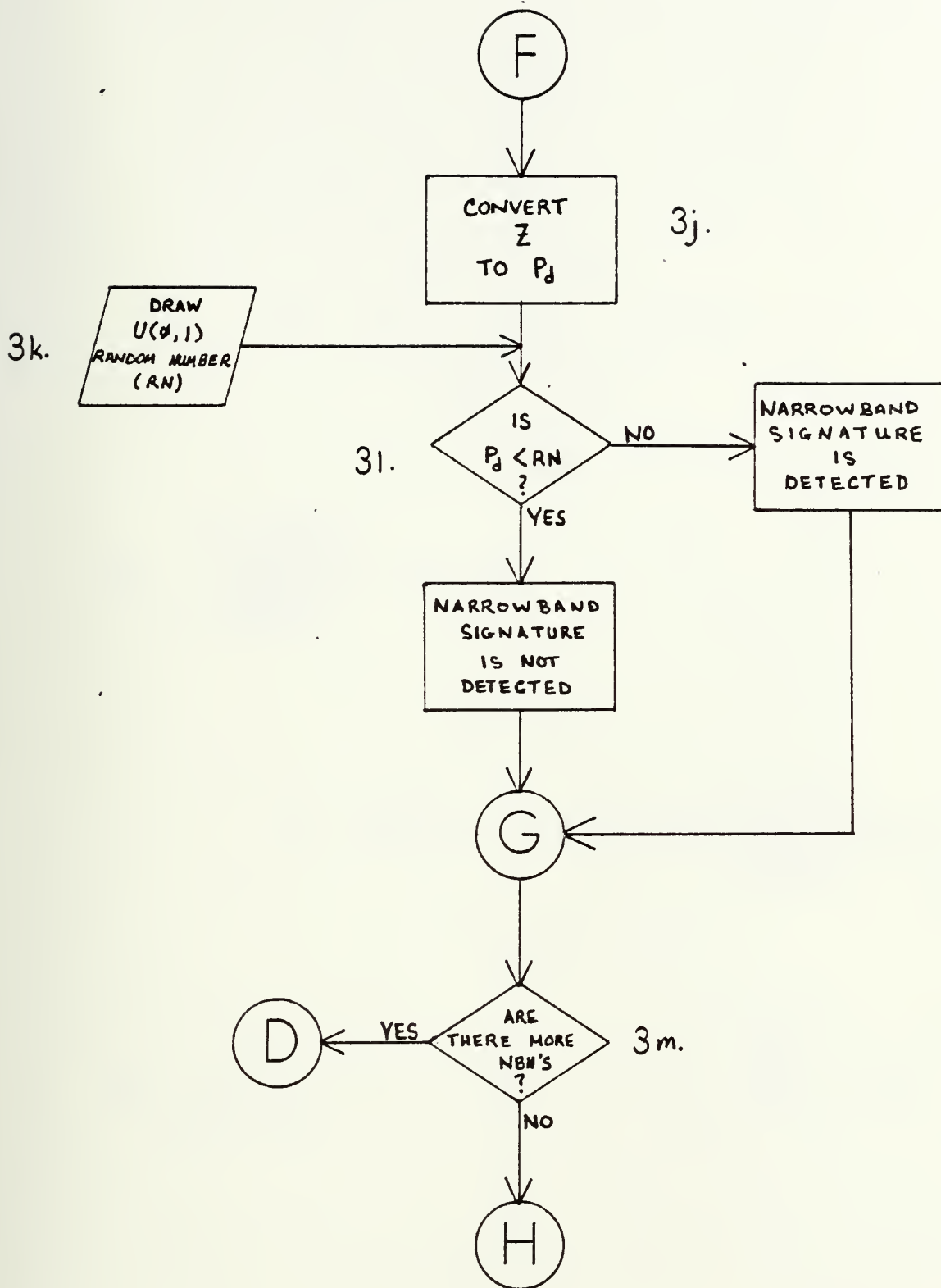
Figure 5-5.   Steps 3j through 3m

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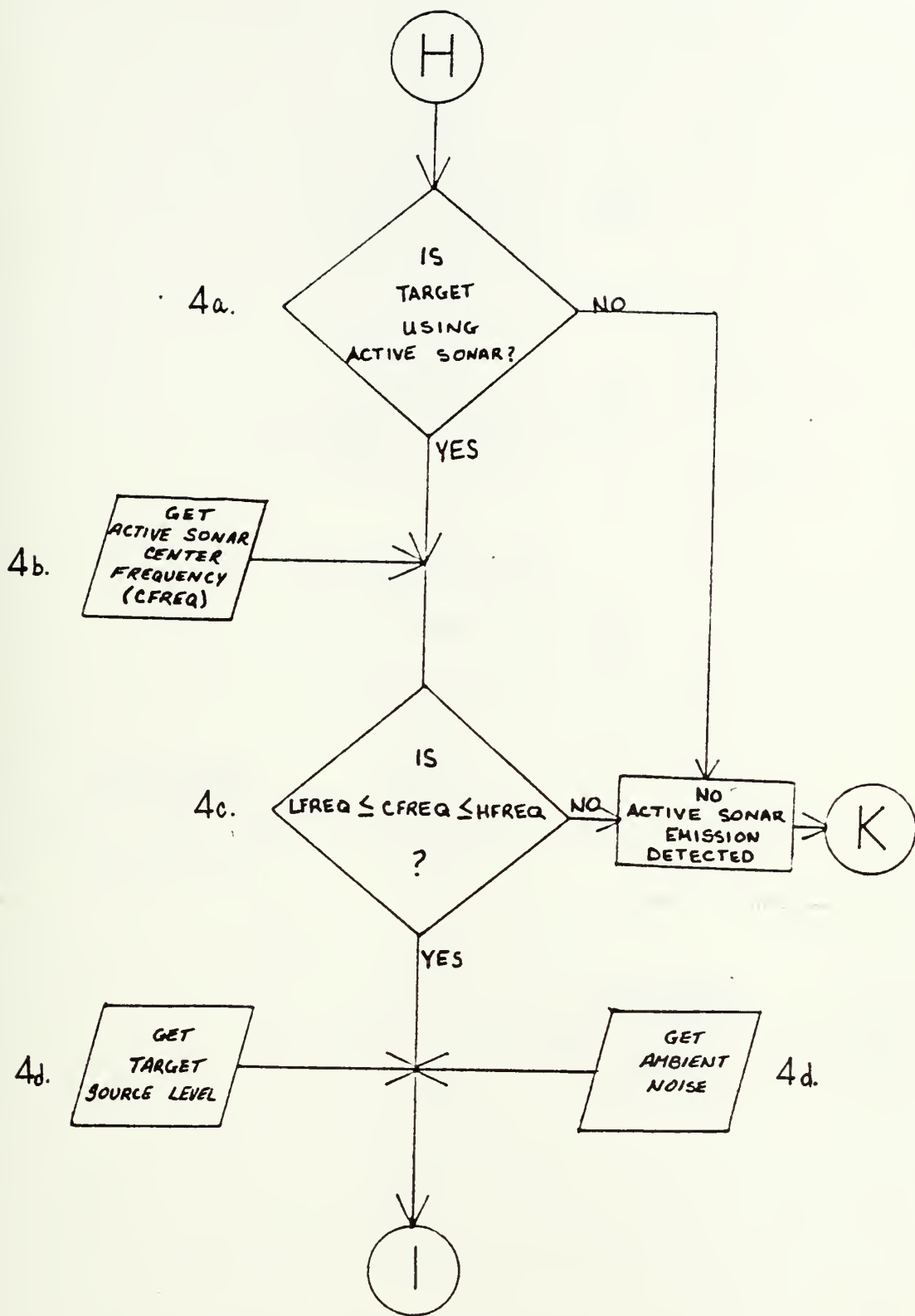
Figure 5-6. Steps 4a through 4d

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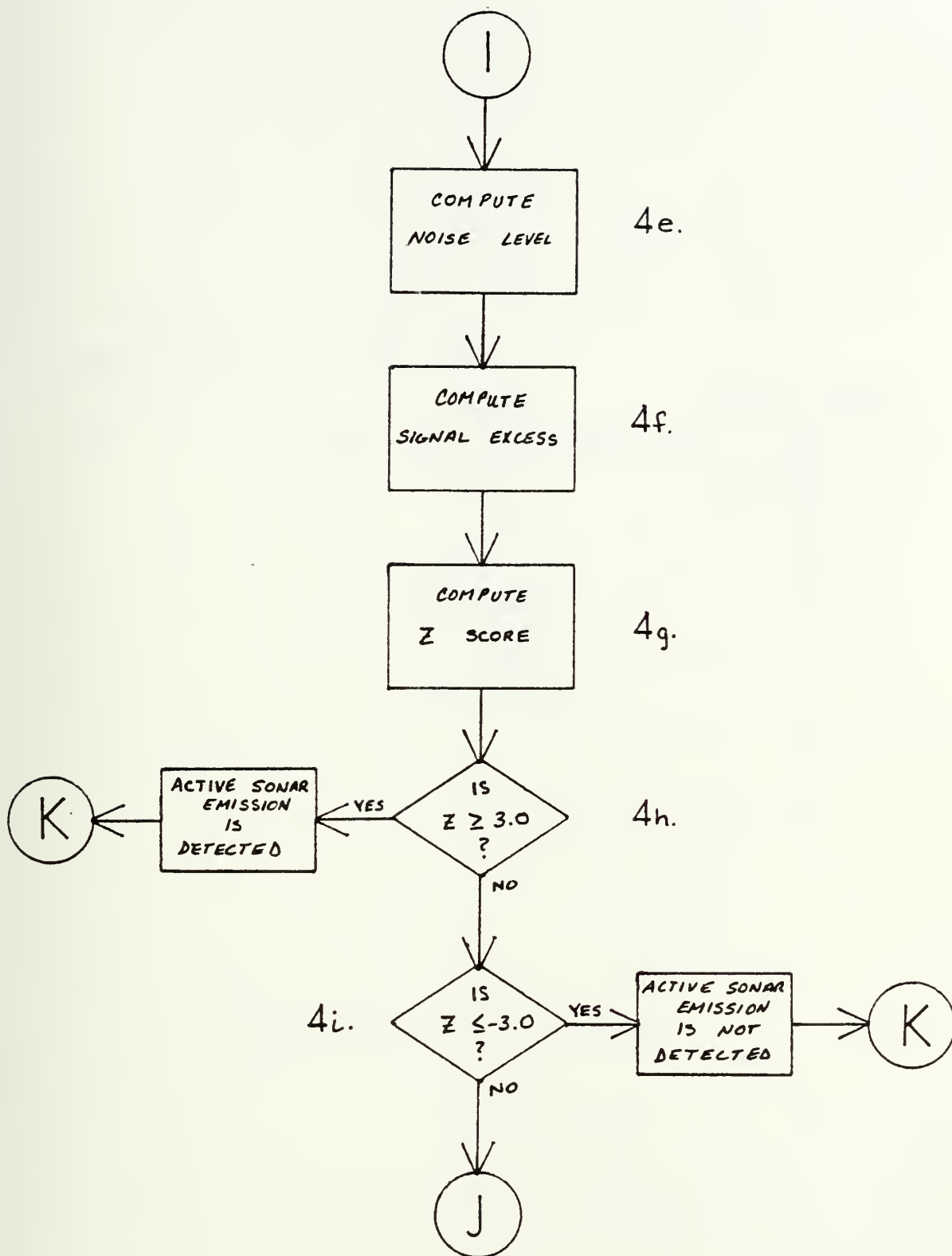
Figure 5-7. Steps 4e through 4i

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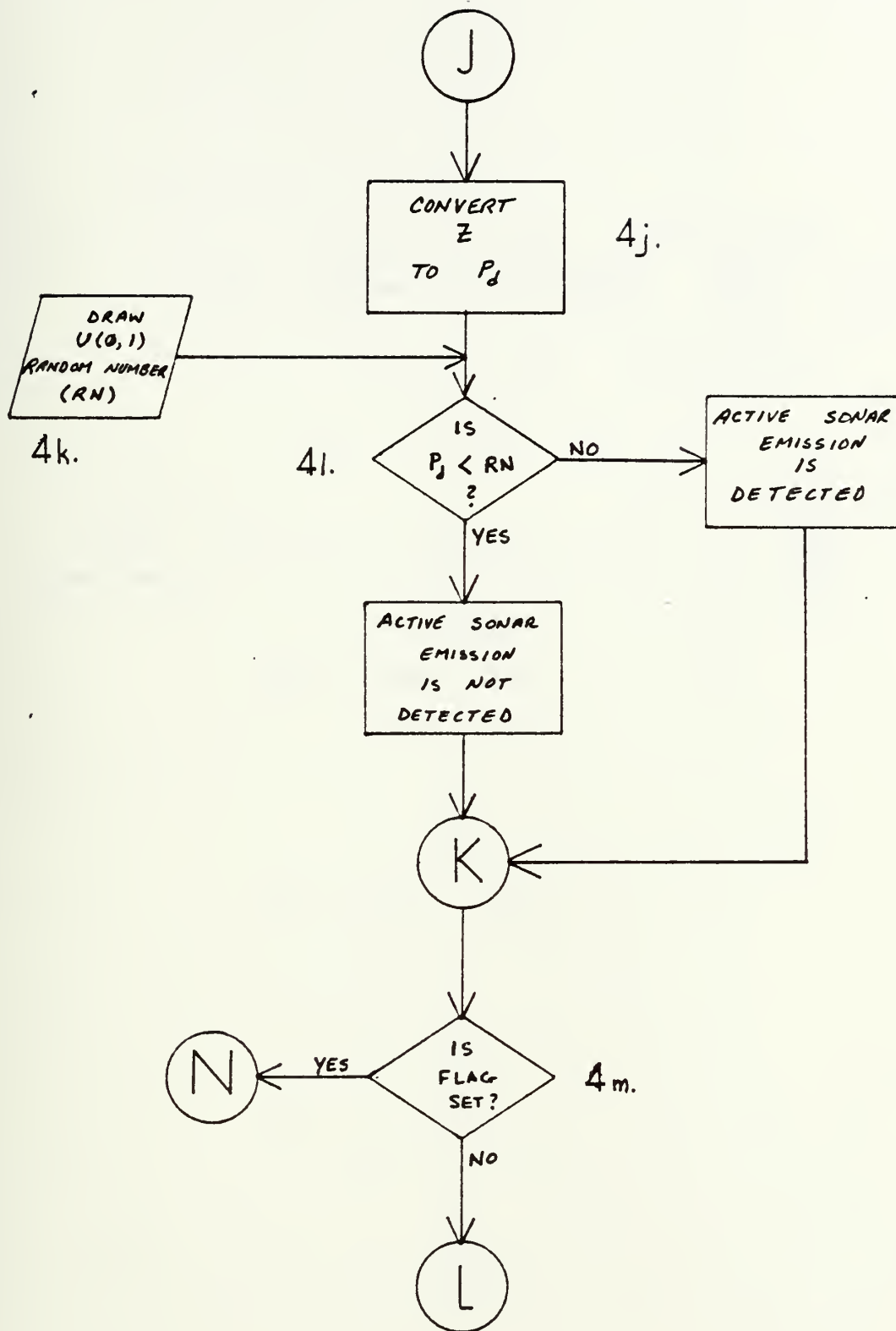
Figure 5-8. Steps 4j through 4m

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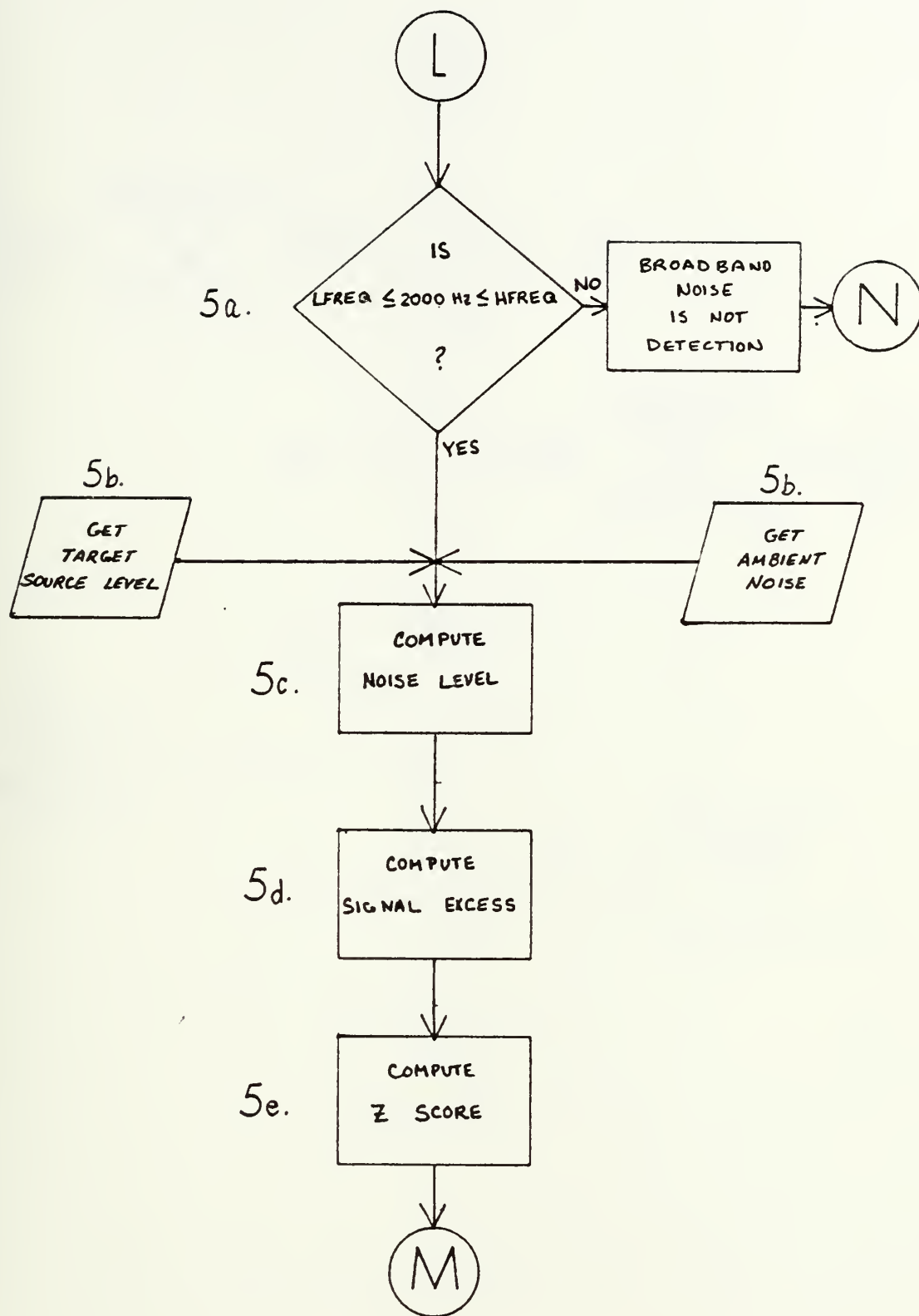
Figure 5-9.   Steps 5a through 5e

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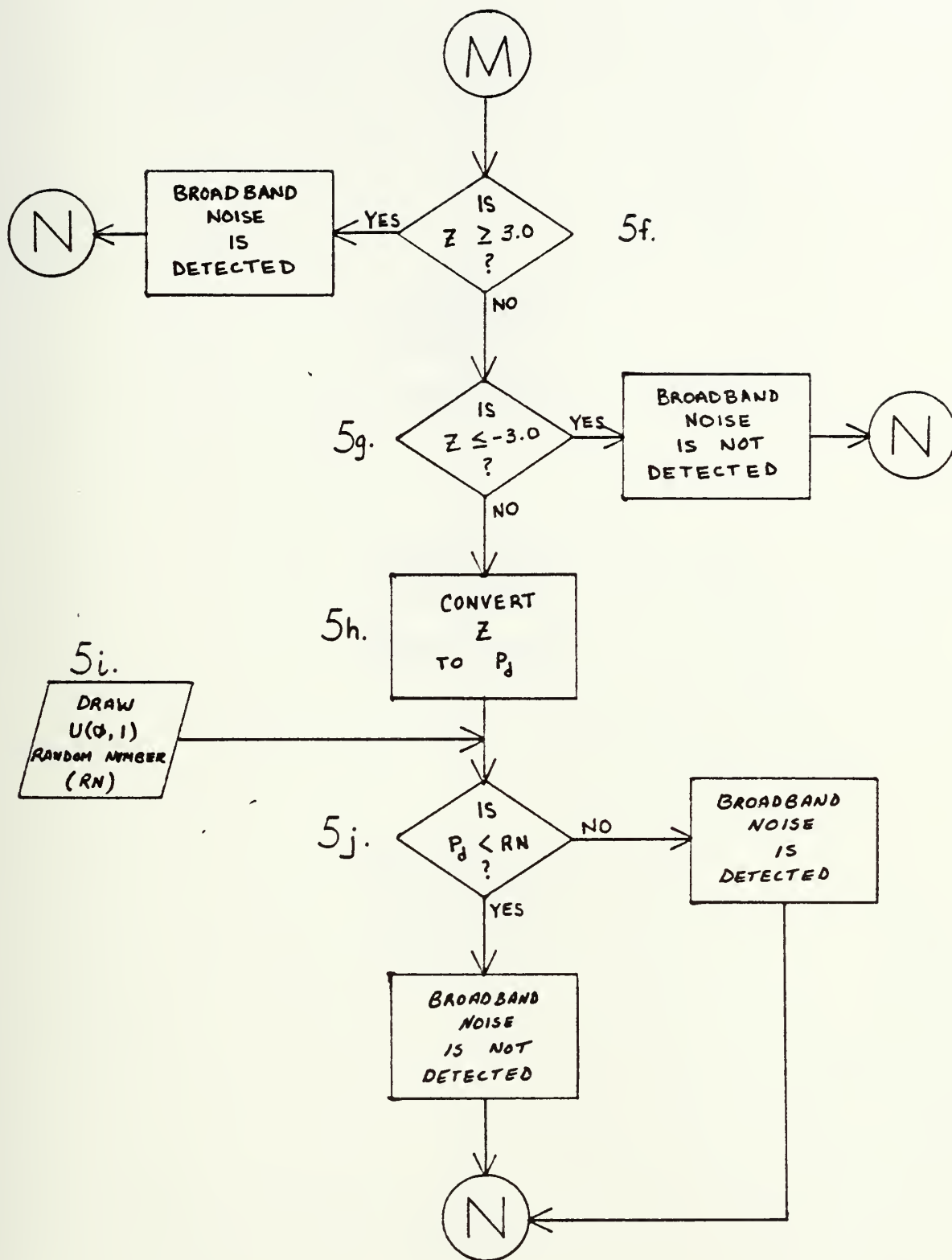
Figure 5-10.   Steps 5f through 5j

55
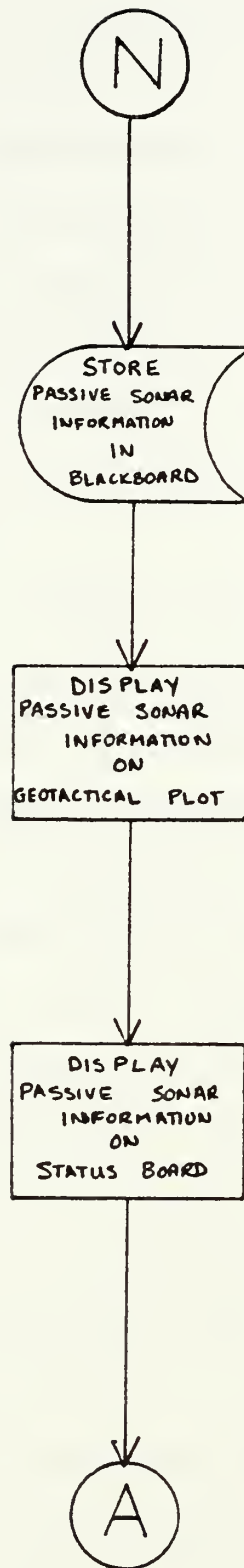
Figure 5-11. Step 6

three acoustic elements: narrowband signature, active sonar emission, or broadband noise. In the flow diagram, the questions, data, and computations pertaining to all three acoustic elements are considered first. The diagram then goes through a loop for each of the acoustic elements to determine whether there is passive contact in any one of the three elements. For the purpose of this explanation the sensor will be referred to as "blue" and the target will be referred to as "orange".

Since "blue" is the detector, the parameters of interest associated with "blue" are the characteristics of the passive sonar system used and those platform characteristics which directly affect sonar performance, for example ship's speed. The parameters associated with "orange" are the characteristics of the platform and the characteristics of the active sonar system used by "orange". All of the above platform and systems performance characteristics are in the appropriate BUILD database file. The remaining parameters are associated with the environment, or ocean medium. These parameters are found in the ENVIRONMENT file. So, the parameters required to determine passive detection can be put into three distinct groups, 1) those associated with the detecting platform; 2) those associated with the target, and 3) those associated with the medium.

The parameters in the passive sonar equation can likewise be separated into those associated with the sensor,

the target, and the medium. Associated with the sensor are
rcognition differential (RD), directivity index (DI), and
detecting platform self noise (SN). Associated with the
target is the target source level (SL). Associated with the
medium are ambient noise (AN) and transmission loss (TL).
These parameters are included in the appropriate database
characteristic and environment files.

The following is a step-by-step explanation of the flow
diagram.

STEP 1a:

Parameters associated with the sensor are retrieved from
the database characteristic files in BUILD.

They are:

1) Sonar system low frequency limit (LFREQ)

2) Sonar system high frequency limit (HFREQ)

3) "Blue" self noise (SN)
    (corresponding to "blue's" speed)

4) Sonar system recognition differential (RD)

5) Sonar system directivity index (DI)
    (corresponding to target angle off the bow)

6) Sonar system vertical beamwidth (VERBW)

7) Sonar system horizontal beamwidth (HZBW)

STEP 1b:

Sonic layer depth (SLD) is retrieved from the
ENVIRONMENT file.

SLD is used to compute the Sensor/Target layer geometry.

STEP 1c:

The following information is extracted from the blackboard:

1) Range from "blue" to "orange"

2) Angle off the bow

3) Vertical angle

4) Horizontal angle

5) Depth of both platforms

6) Speed of both platforms

7) Maximum sonar range

STEP 2a:

Check the range from "blue" to "orange".

If the range from "blue" to "orange" is greater than the maximum sonar range there is no passive sonar detection. Proceed to examine next target/sensor pair for passive sonar detection. (Maximum sonar range is a blackboard parameter typically set to 120 nautical miles by the operator during scenario preparation using FORCE or during the game.)

If the range is less than or equal to the maximum sonar range, the detection process continues.

STEP 2b:

Check vertical angle between the sensor and the target.

If the angle is greater than VERBW, there is no passive detection. Proceed to next target/sensor pair.

If the angle is less than or equal to VERBW, continue with Step 2c.

STEP 2c:

Check horizontal angle between the sensor and the target.

If the angle is greater than HZBW, set flag and proceed
to Step 4a. (Note: The flag is set because NWISS
allows active emissions to be detected even if the
target is outside the horizontal beamwidth of the
detecting platform.)

If the angle is less than or equal to HZBW, continue
with Step 3a.

STEP 3a:

Determine if "orange" has any narrowband frequencies.

If "orange" has narrowband frequencies continue with
Step 3b.

If "orange" has no narrowband frequencies proceed to
Step 4a.

STEP 3b:

Retrieve "orange's" narrowband frequencies from the
BUILD file. (Labeled NBN_).

STEP 3c:

Check if "orange's" narrowband frequency is greater than
or equal to "blue's" low frequency limit and less than
or equal to "blue's" high frequency limit (i.e., Is
LFREQ <= NBN_ <= HFREQ?).

If NBN_ does lie between LFREQ and HFREQ inclusive,
continue with Step 3d.

If NBN_ does not lie between LFREQ and HFREQ inclusive,
passive sonar detection of the narrowband frequency is
not possible. Proceed to Step 3m.

STEP 3d:

Retrieve "orange" target source level from BUILD file,
ambient noise and transmission loss from ENVIRONMENT
file.

STEP 3e:

Compute the noise level (NL).

Noise level is the power sum of "blue" self noise and ambient noise.

$$NL = 10 \log [10^{(AN/10)} + 10^{(SN/10)}]$$

STEP 3f:

Compute signal excess (SE).

$$SE = SL - NL - TL - RD + DI$$

STEP 3g:

Compute Z score.

$$Z = SE/2$$

STEP 3h:

Is Z greater than or equal to 3.0?

If Z >= 3.0 passive sonar detection of the narrowband frequency is made (i.e., there is a 100% probability of detection). Proceed to step 3m.

If Z < 3.0 continue with Step 3i.

STEP 3i:

Is Z greater than or equal to -3.0?

If Z <= -3.0 passive sonar detection of the narrowband frequency is not made (i.e., there is a 0% probability of detection). Proceed to Step 3m.

If Z > -3.0 (i.e., -3.0 < Z < 3.0) continue with Step 3j).

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STEP 3j:

Convert Z score to a probability of detection (P_d) from a table of cumulative standard normal distribution.

STEP 3k:

Draw a random number (RN) from a uniform (0,1) distribution.

STEP 3l:

Compare the probability of detection to the random number.

If P_d >= RN, passive detection of the narrowband frequency is made.

If P_d < RN, passive detection of the narrowband frequency is not made.

STEP 3m:

Check for more narrowband frequencies.

If there are more narrowband frequencies return to Step 3b.

If there are no more narrowband frequencies continue with Step 4a.

STEP 4a:

Check for active sonar emissions from "orange".

If "orange" is not using active sonar proceed to Step 5a.

If "orange" is using active sonar continue with Step 4b.

STEP 4b:

Retrieve "orange's" active sonar frequency and source level from the BUILD file. (Labeled CFREQ and LEVEL, respectively).

STEP 4c:

Check if active sonar center frequency is greater than
or equal to "blue's" low frequency limit and less than
or equal to "blue's" high frequency limit (i.e., Is
LFREQ <= CFREQ <= HFREQ?).

If CFREQ does lie between LFREQ and HFREQ inclusive,
continue with Step 4d.

If CFREQ does not lie between LFREQ AND HFREQ inclusive,
passive sonar detection of the active sonar emission is
not possible. Proceed to Step 5a.

STEP 4d:

Retrieve ambient noise and transmission loss from
ENVIRONMENT file.

STEP 4e:

Compute the noise level (NL).

Noise level is the power sum of "blue" self noise and
ambient noise.

$$NL = 10 \log [10^{(AN/10)} + 10^{(SN/10)}]$$

STEP 4f:

Compute signal excess (SE).

$$SE = SL - NL - TL - RD + DI$$

STEP 4g:

Compute Z score.

$$Z = SE/2$$

STEP 4h:

Is Z greater than or equal to 3.0?

If Z >= 3.0 passive sonar detection of the active sonar emission is made (i.e., there is a 100% probability of detection). Proceed to Step 5a.

If Z < 3.0 continue with Step 4i.

STEP 4i:

Is Z less than or equal to -3.0?

If Z <= -3.0 passive sonar detection of the active sonar emission is not made (i.e., there is a 0% probability of detection). Proceed to Step 5a.

If Z > -3.0 (i.e., -3.0 < Z < 3.0) continue with Step 4j.

STEP 4j:

Convert Z score to a probability of detection (P_d) from a table of cumulative standard normal distribution.

STEP 4k:

Draw a random number (RN) from a uniform (0,1) distribution.

STEP 4l:

Compare the probability of detection to the random number.

If P_d >= RN, passive detection of the active sonar emission is made.

If P_d < RN, passive detection of the active sonar emission is not made.

STEP 4m:

Check for the flag set in Step 2c.

If flag is set proceed to Step 6a.

If flag is not set continue with Step 5a.

STEP 5a:

Check for broadband noise detection. Is 2000 Hz greater
than or equal to "blue" low frequency limit and less
than or equal to "blue" high frequency limit? (i.e., Is
LFREQ <= 2000 Hz <= HFREQ?)

If 2000 Hz lies between LFREQ and HFREQ inclusive,
continue with Step 5b.

If 2000 Hz does not lie between LFREQ and HFREQ
inclusive, passive sonar detection of broadband noise is
not possible. Proceed to Step 6.

STEP 5b:

Retrieve "orange" target source level from BUILD file,
ambient noise and transmission loss from ENVIRONMENT
file.

STEP 5c:

Compute the noise level (NL).

Noise level is the power sum of "blue" self noise and
ambient noise.

$$NL = 10 \log [{}^{(AN/10)} + 10^{((SN-27)/10)}]$$

STEP 5d:

Compute signal excess (SE).

$$SE = (SL-27) - NL - TL - RD + DI$$

STEP 5e:

Compute Z score.

$$Z = SE/2$$

STEP 5f:

Is Z greater than or equal to 3.0?

If Z >= 3.0 passive sonar detection broadband noise is made (i.e., there is a 100% probability of detection). Proceed to Step 6.

If Z < 3.0 continue with Step 5g.

STEP 5g:

Is Z less than or equal to -3.0?

If Z <= -3.0 passive sonar detection of broadband noise is not made (i.e., there is a 0% probability of detection). Proceed to Step 6.

If Z > -3.0 (i.e., -3.0 < Z < 3.0) continue with Step 5h.

STEP 5h:

Convert Z score to a probability of detection (P_d) from a table of cumulative standard normal distribution.

STEP 5i:

Draw a random number (RN) from a uniform (0,1) distribution.

STEP 5J:

Compare the probability of detection to the random number.

If P_d >= RN passive detection of broadband noise is made.

If P_d < RN passive detection of broadband noise is not made.

STEP 6:

Results of the passive detection process.

All of the information determined by the detection process is made available to the blackboard for retrieval by the status board and geotactical display programs. It is then displayed to the player on the appropriate status board and on the geotactical display.

TABLE 5-1

Passive Sonar Status Board

View: BLUE1			PASSIVE SONAR STATUS BOARD - Page 1									Game Time: 010444
								----- TMA -----				
DET	TRACK	TIME	CLASS	SB	BRG	BB	ECHO	RNG	CRS	SPD	QUAL	----LINE FREQ----
DD1	BP001 (ECHO2)	0219	POSSB		003 (000)	Y						
DD1	BP002 (ECHO2)	0324	POSSB		000 (000)	Y						

A sample passive status board is shown in Table 5-1. The following is an explanation of what is displayed in each column:

Column 1. DET: Displays the name of the detecting platform.

Column 2. TRACK: Displays the track number of the contact. (On a control station status board the name of the contact is also displayed in parentheses below the track number).

Column 3. TIME: Displays time of last detection.

Column 4. CLASS: Displays classification of detection.

Column 5. SB: Displays the number of the sonobuoy in contact if the detection is made by a sonobuoy.

Column 6. BRG: Displays bearing to the contact with the bearing error applied. (On a control status board the actual bearing is also displayed in parentheses.)

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Column 7.   BB: Displays a Y if the contact is generated
            by a broadband noise detection.

Column 8.   ECHO: Displays the center frequency of the
            active sonar if active sonar emissions are
            detected.

Columns   TMA: Displays target motion analysis
  9 - 12.   information.

Columns   LINE FREQ: Displays narrowband frequencies
 13 - 15.   if the target's narrowband signature was
            detected.

The geotactical display uses NTDS symbology to display

platforms and bearing lines to contacts.   Each bearing line

is identified by the track number.

VI. DETERMINING FIGURE OF MERIT AND ITS APPLICATIONS TO NWISS

The figure of merit (FOM) is a measure of a particular sonar system's capability against a specific target in a distinct ocean area. In NWISS the FOM is governed by the following equation:

$$FOM = SL - NL - RD + DI \qquad (6-1)$$

FOM is computed by assuming a target source level, noise level, recognition differential, and directivity index. By definition of the recognition differential, the figure of merit represents the allowable transmission loss for a 50 percent probability of detection (See Chapter III, Eq. 3-2).

In NWISS there are no assumptions made in the calculation of FOM since the values for the parameters in Equation 6-1 are tabled, or are computed from tabled data. To illustrate the calculation of FOM the following simple scenario is used. With the FOM computed, the applications discussed in Chapter I can be shown.

The scenarios involve a U.S. surface ship versus an enemy submarine in two different environmental areas. The first environment is a generic environment developed at IBGTT/CSF called KGOOD.ENV. The second environment, which has been given the fictitious name of A123D, uses actual

Fleet Numerical Oceanographic Center data generated for a
specific ocean area. By using the two environment areas, a
comparison can be made between the two results to show the
applications of the passive sonar model and the figure of
merit. The objective is to compute the figure of merit for
the particular scenario, then compare it to the transmission
loss data in the environment file to determine ranges of
detection. Appendix A discusses the environment files as
well as providing the environment files used in the
scenarios.

A. SCENARIOS

A U.S. surface ship operating in a sonar region with
environment KGOOD.ENV is in a passive sonar encounter with
an enemy submarine. The ship is doing 12 kts. on a course
of 360 degrees T. The submarine is doing 10 kts. on a
course of 150 degrees T, and operating at a depth of 350
feet. The bearing from the ship to the submarine is 355
degrees T.

   1.   Identifying the Parameters

         To begin we look at the database characteristic file
of the ship, Figure 6-1. Because the ship is the detecting
platform, the only parameter of interest is in the line
labeled SONAR. The name of the passive sonar system is
sought, in this case PSON1. The data contributing to FOM
corresponding to the detecting platform can now be found in

```
CLASS   SSHIP
CAT     SURF
TYPE    FF
VMAX        27
XSECT       31
HDG     GYRO
SPD     PTLOG
CLRNG       15
DTRNG       21
TRKS        75
BBN        128      140     144     163     160     165
NAV     SRN12
LCHRT        1
RECRT        1
WAVE        20
LACOM       20
LASEN       20
LAWPN       30
LAFLD        5
LASPD       10
LAAIR       10
RBOC         2       48
NBN         91      144
DECM    YES
BLIP    YES
RDESM   SPS10       75
RDESM   SPS40       90
RDESM   WLR1        70
RDESM   SLR12       50
RDESM   SPG53       80
RDESM   LN66        90
RDESM   MK115       60
RDESM   URD4        60
SONAR   PSON1
SONAR   ASON1
COMMS   UHF         80
COMMS   HF          80
COMMS   VHF        100
MISS    HRPON        4
BUOY    SSQ53   SONO        300
BUOY    SSQ47   SONO        200
WEAP    SSPRO   SAM           8
WEAP    G554    GUN         600
WEAP    MK46A   TORP         20
WEAP    ASROC   TORP         12
WEAP    MK46    TORP         22
AIR     SH2F          1
```

Figure 6-1.   Database Characteristic File of
               Surface Ship

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the database characteristic file of the sonar PSON1, Figure 6-2. The parameters in Figure 6-2 used to compute FOM are RD, DI, BBN, and NBN. But first, the ability of the sonar system to detect the frequencies of interest must be determined. To do this, the parameters LFREQ and HFREQ are compared to the frequency of interest which identify the target in each of the acoustic elements.

The frequencies of interest are 2000 Hz for broadband noise detection, the narrowband frequencies of the target, and the center frequency of the active sonar employed by the target. The narrowband frequencies and the center frequency of the active sonar are found in the characteristic files of the submarine and the active sonar, Figures 6-3 and 6-4, respectively. From Figure 6-3, the narrowband frequencies of the submarine are 300 Hz and 585 Hz. From Figure 6-4, the center frequency of the active sonar is 3000 Hz.

Returning to Figure 6-2, we note that LFREQ and HFREQ are 300 Hz and 2500 Hz, respectively. Therefore, the detection of the broadband noise and the narrowband signature is possible, while the detection of active sonar emissions is not since CFREQ is outside the range of LFREQ and HFREQ. Now we can examine the other parameters in Figure 6-2, noting in Table 4-1 that the narrowband frequencies 300 Hz and 585 Hz correspond to lines NBN11 and NBN12, respectively.

```
NAME      PSON1
CAT       PHULL
CFREQ     2000
LFREQ      300
HFREQ     2500
HZBW         8
VERBW       45
BRERR        2
RD         -12
DI00        21    21    21    21    21    21
DI60        21    21    21    21    21    21
DI120       21    21    21    10     0   -10
BBN         64    65    69    79    84    84
NBN1       300   300   300   300   300   300
NBN2       300   300   300   300   300   300
NBN3       300   300   300   300   300   300
NBN4       300   300   300   300   300   300
NBN5       300   300   300   300   300   300
NBN6       300   300   300   300   300   300
NBN7       300   300   300   300   300   300
NBN8       300   300   300   300   300   300
NBN9       300   300   300   300   300   300
NBN10      300   300   300   300   300   300
NBN11       73    77    77    80    82   300
NBN12       56    62    63    67    67   300
NBN13       46    53    54    59    62   300
NBN14       41    45    45    51    57   300
NBN15       39    41    43    51    57   300
NBN16       37    38    42    52    57   300
NBN17       36    37    41    51    57   300
NBN18      300   300   300   300   300   300
NBN19      300   300   300   300   300   300
NBN20      300   300   300   300   300   300
```

Figure 6-2. Database Characteristic File of Passive Sonar
            System

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```
CLASS    SSUB
CAT      NSUB
TYPE     SSGN
VMAX       22
XSECT      22
HDG      GYRO
SPD      PTLOG
CLRNG       6
DTRNG      10
TRKS       75
BBN       137    139    141    143    145    147
DRATE     250
KEEL       30
PSCOP      60
DR       SINS
OMEGA    LWSPT
NBN       300    145
NBN       585    139
RDESM    SNPTR    20
RDESM    BRKSP    60
SONAR    PSON2
SONAR    ASON2
COMMS    HF       90
COMMS    UHF      90
MISS     SSN7      8
NAV      NAVST
TORP     ET80     32
WIRES       3
```

Figure 6-3.   Database Characteristic File of a Submarine


```
>NAME      ASON2
>CAT       AHULL
>CFREQ     3000
>LEVEL      240
MNFAL      4320
MNRPR      1440
MODE       DP
MODE       CZ
```

Figure 6-4.   Database Characteristic File of Active Sonar
             System

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The first parameter of interest is RD, it has a value of -12. To determine DI, note that the submarine is within 10 degrees of the bow of the ship, so we look at the first entry in line DI00. DI has a value of 21. Next, locate the values of self noise, both for the broadband case and the narrowband case. Since the ship is at 12 kts. the value of SN will be in the 10 kts. column, the second one from the left. In line BBN, that value is 65 dB. In lines NBN11 and NBN12 the values are 77 dB and 62 dB, respectively.

Figure 6-3 provides the parameters associated with the submarine. In this case there is only the target source level to determine. Since the submarine is doing 10 kts., the second column in the BBN line and the two NBN lines will provide the values for SL. In the broadband detection case SL is equal to 139 dB. In the narrowband detection case there is an SL for each frequency of interest. SL for the 300 Hz frequency is 145 dB, and for the 585 Hz frequency SL equals 139 dB.

Finally, the one parameter left to consider is the ambient noise. There is a separate ambient noise value for each of the frequencies of interest. This value for AN is drawn from the environment file KGOOD.ENV. In the broadband detection case the value of AN is read directly below the 2000 Hz in the ambient noise line. For this scenario AN

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equals 57 dB for the broadband detection case. The AN for
the 300 Hz frequency is read beneath 315 Hz in the ambient
noise line and for the 585 Hz frequency under 630 Hz. For
the 300 Hz case, AN equals 67 dB, and for the 585 Hz case,
AN equals 65 dB. Table 6-1 is provided in summary.

TABLE 6-1

Summary of Detection Process

DETECTING PLATFORM	TARGET
RD = -12 DB	Broadband noise: SL = 139 dB
DI = 21 dB	
	Narrowband signature:
Broadband noise:	SL = 145 dB (300 Hz)
SN = 65 dB	SL = 139 dB (585 Hz)
Narrowband signature:	
SN = 77 dB (300 Hz)	
SN = 62 dB (585 Hz)	

ENVIRONMENT KGOOD	ENVIRONMENT A123D
Sonic Layer Depth=164 Ft	Sonic Layer Depth=314 Ft
Broadband noise:	Broadband noise:
AN = 57 dB	AN = 87 dB
Narrowband signature:	Narrowband signature:
AN = 67 dB (300 Hz)	AN = 85 dB (300 Hz)
AN = 65 dB (585 Hz)	AN = 86 dB (585 Hz)

2. Calculating FOM

The figure of merit is calculated using Equation
6-1. The variables SL, RD, and DI are in Table 6-1. NL

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must be computed using Equation 4-2 for the narrowband case and Equation 4-5 for the broadband case. Equation 4-2 yields a NL of 77.4 for the 300 Hz narrowband signature detection case. Equation 4-2 yields a NL of 66.8 for the 585 Hz narrowband signature detection case. Equation 4-5 yields a NL of 57.1 for the broadband detection case.

There are three FOM's associated with this scenario, one for the broadband noise detection case and one for each of the two narrowband frequency cases. The following are the results of calculating FOM for each of the three cases:

Broadband noise:

$$FOM = 139 - 57.1 - (-12) + 21$$
$$FOM = 87.9 \text{ dB}$$

300 Hz narrowband signature:

$$FOM = 145 - 77.4 - (-12) + 21$$
$$FOM = 100.6 \text{ dB}$$

585 Hz narrowband signature:

$$FOM = 139 - 66.8 - (-12) + 21$$
$$FOM = 105.2$$

Figures 6-5, 6-6, and 6-7 show the computed FOM plotted on transmission loss curves for the respective frequencies of interest and source/receiver layer

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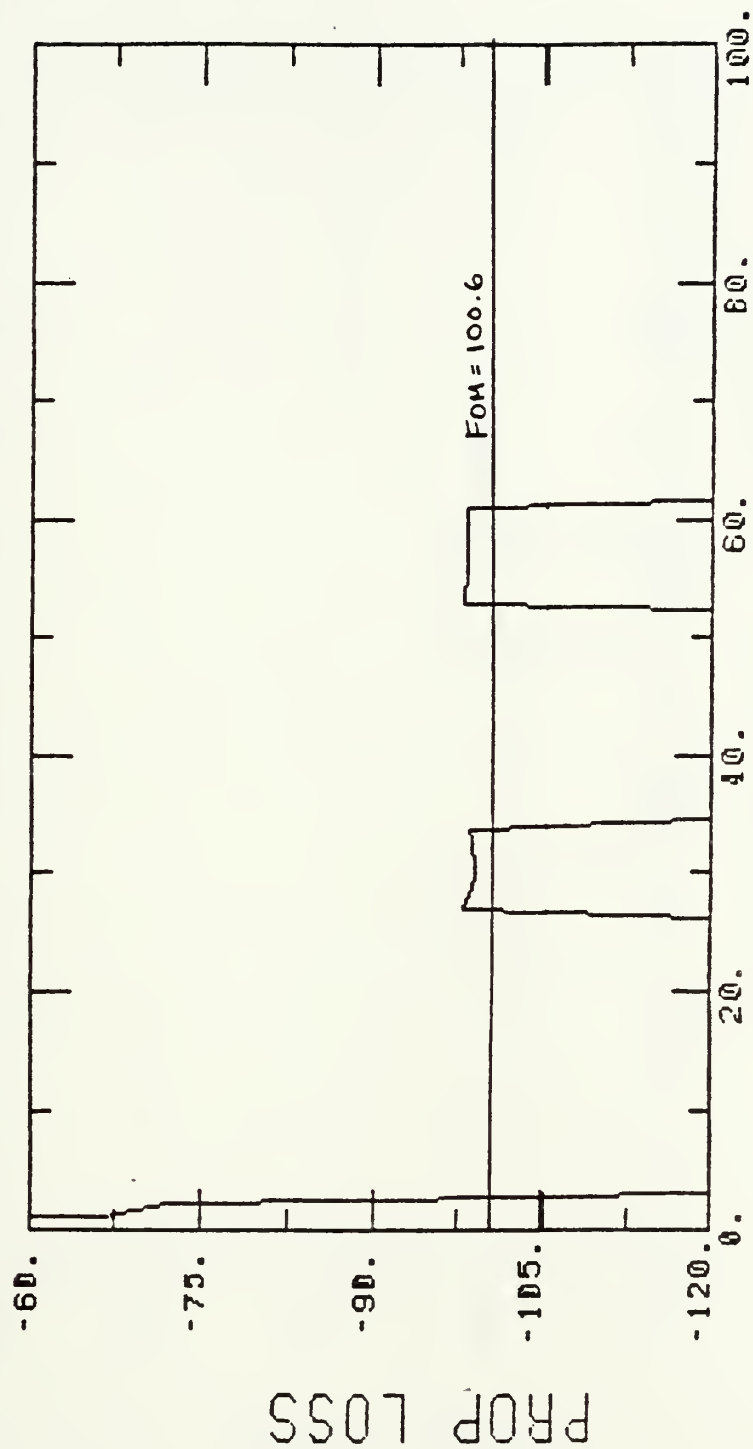
Figure 6-5. FOM vs. TL, 300 Hz, KGOOD Environment

78
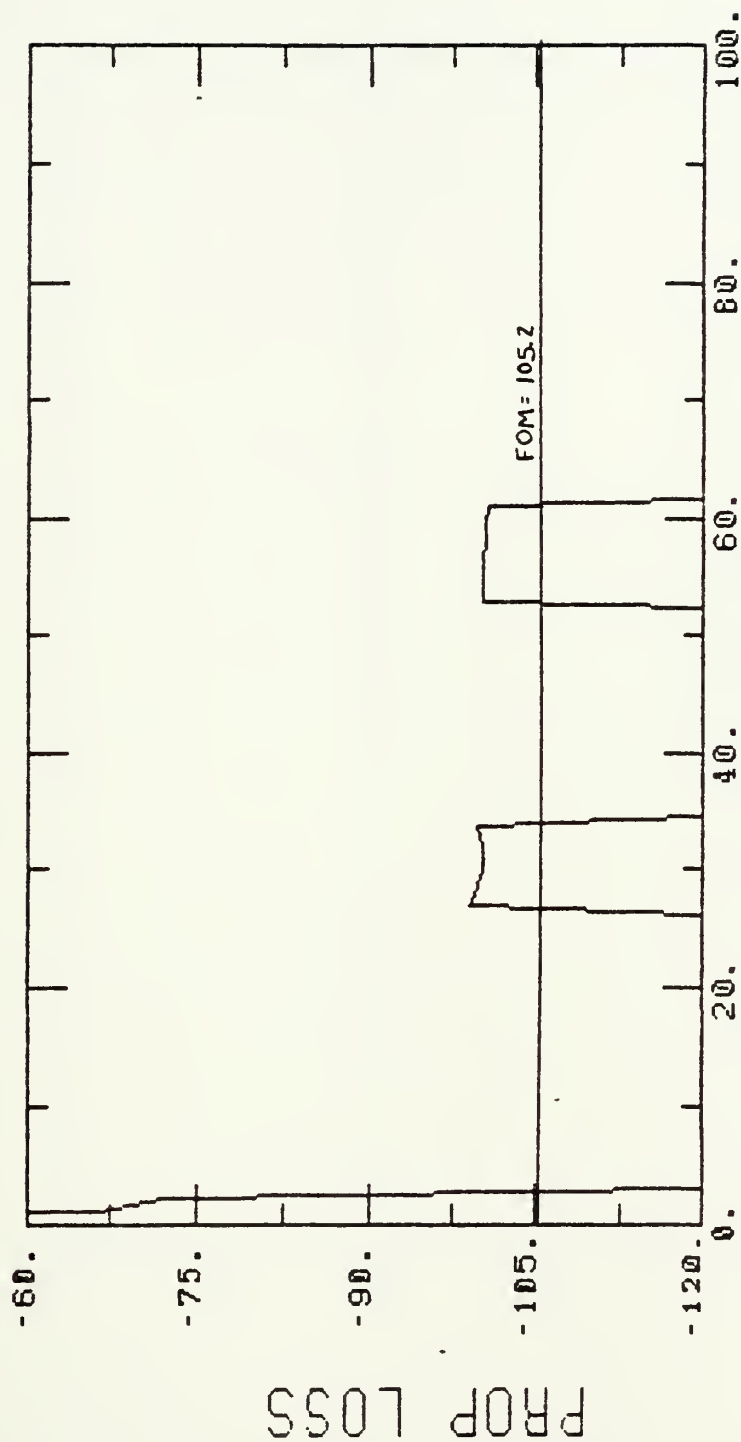
Figure 6-6. FOM vs TL, 585 Hz, KGOOD Environment

79
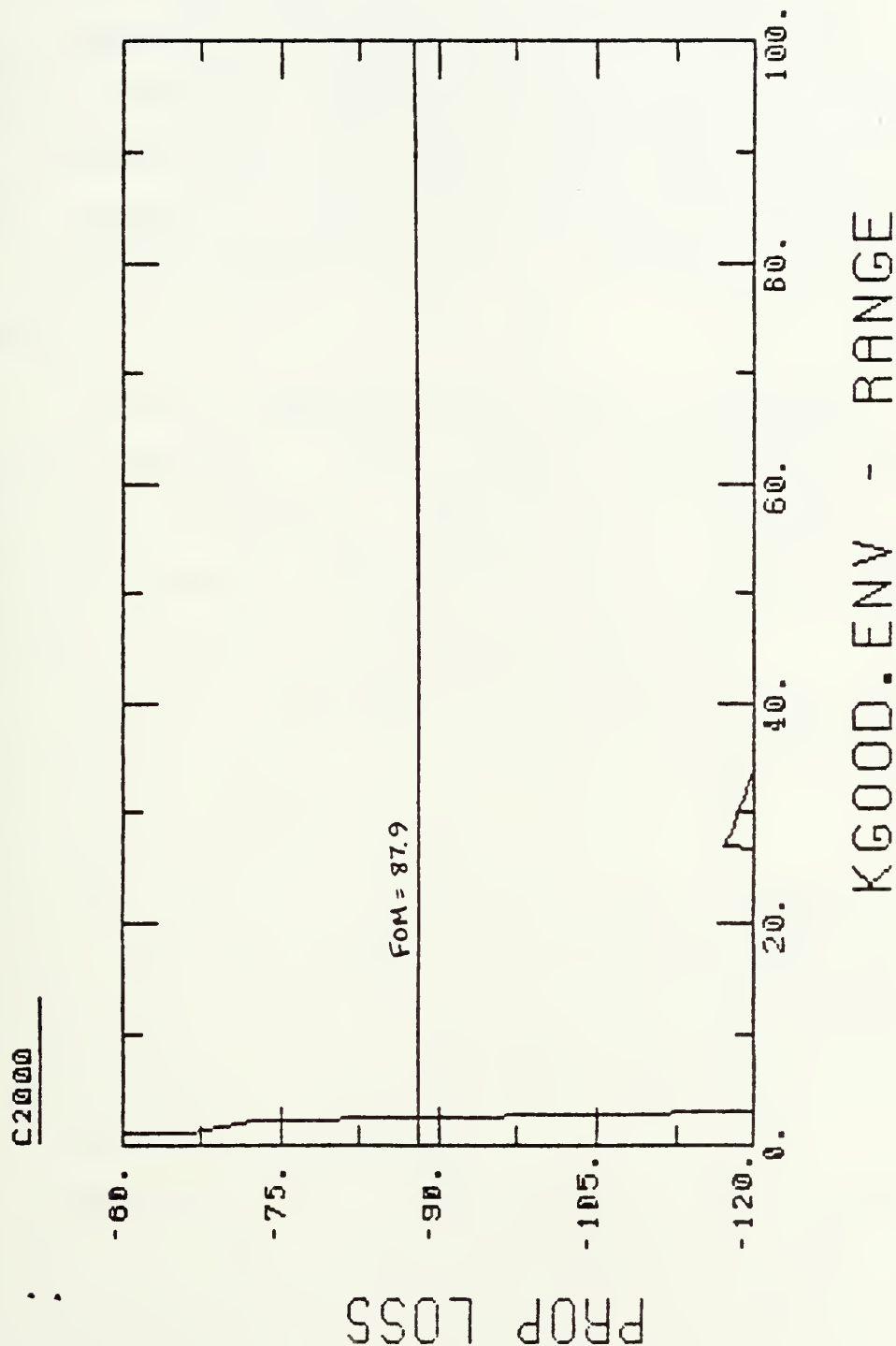
Figure 6-7. FOM vs. TL, Broadband Noise, KGOOD Environment

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geometries. From each graph, the 50 percent probability of detection is read where the FOM line intersects the transmission loss curve.

Figure 6-5 represents the 300 Hz narrowband signature detection. The plotted FOM yields direct path and two convergence zone (CZ) passive sonar capability. The 50 percent probability of detection ranges are 4 NM for direct path, 28 NM to 33 NM for first CZ, and 54 NM to 61 NM for second CZ.

Figure 6-6 represents the 585 Hz narrowband signature detection. It also shows a direct path and two CZ passive sonar capability. The 50 percent probability of detection ranges are 3 NM for direct path, 28 NM to 33 NM for first CZ, and 53 to 61 NM for second CZ.

Figure 6-7 represents the broadband noise detection. The plotted FOM yields only a 3 NM direct path 50 percent probability of detection range.

The results of the expected ranges of detections above are reasonable because the environment KGOOD was modified to give those results. In using an environment file representing an actual ASW zone such as A123D, the results may not be so pleasing.

The FOM's for the case using environment A123D are computed in the same manner as previously discussed. The difference being the sonic layer depth, the ambient noise,

and the transmission loss curves used. The data
corresponding to environment A123D is shown in Table 6-1.
The computed FOM's are shown below.

Broadband noise:

$$FOM = 139 - 87.0 - (-12) + 21$$
$$FOM = 85.0 \text{ dB}$$

300 Hz narrowband signature:

$$FOM = 145 - 85.6 - (-12) + 21$$
$$FOM = 92.4 \text{ dB}$$

585 Hz narrowband signature:

$$FOM = 139 - 87.0 - (-12) + 21$$
$$FOM = 85 \text{ dB}$$

Figures 6-8, 6-9, and 6-10 are examples of using the
transmission loss curves of environment A123D. The three
figures show that only direct path detection will be
observed. Note that for the 300 Hz narrowband detection,
the 50 percent probability of detection range is 38 NM,
while for the 585 Hz narrowband and the broadband
detections, the 50 percent probability of detection ranges
are 10 NM and 8 NM, respectively.

The 300 Hz narrowband detection results in an
example of obtaining unreasonable detection ranges for the
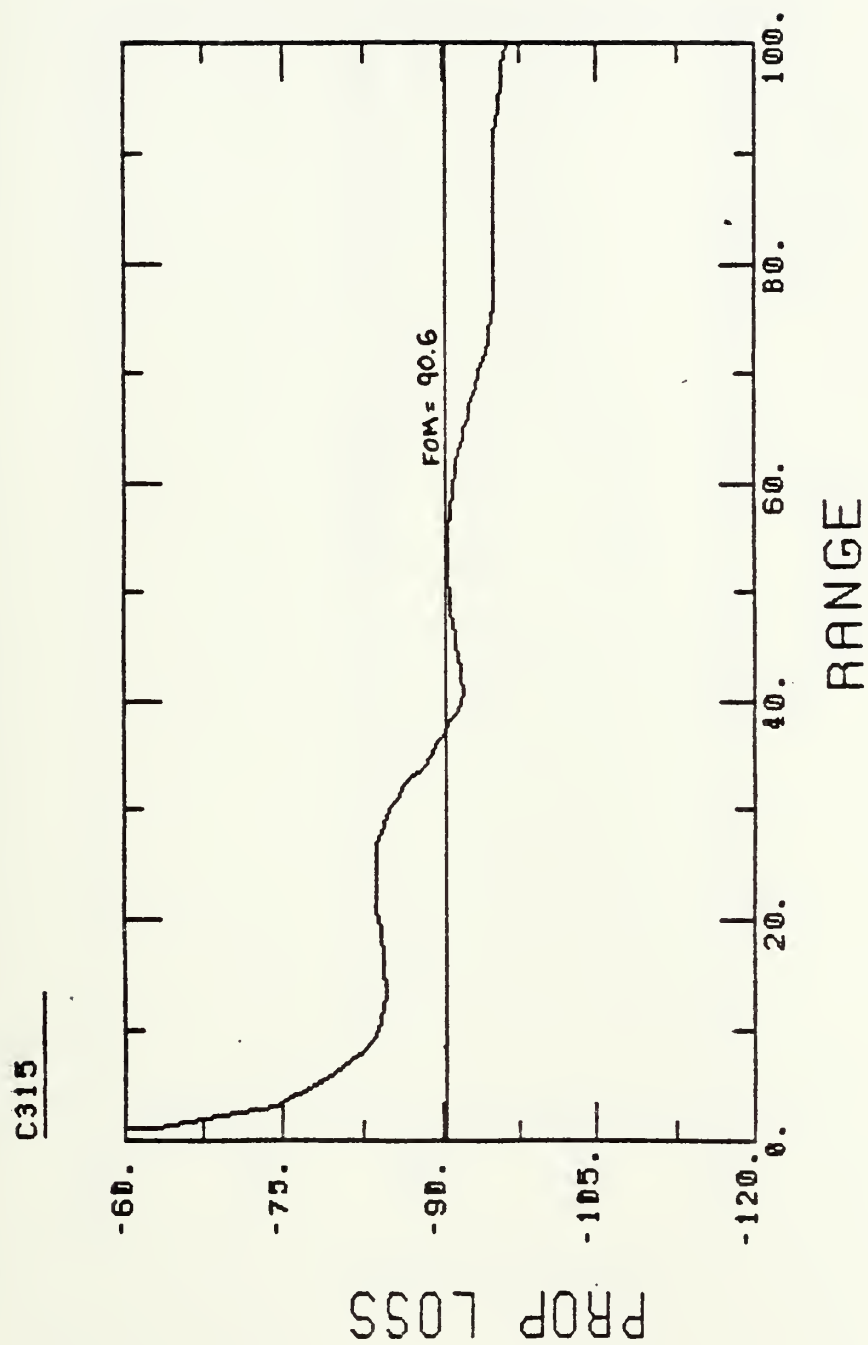
Figure 6-8. FOM vs. TL, 300 Hz, A123D Environment

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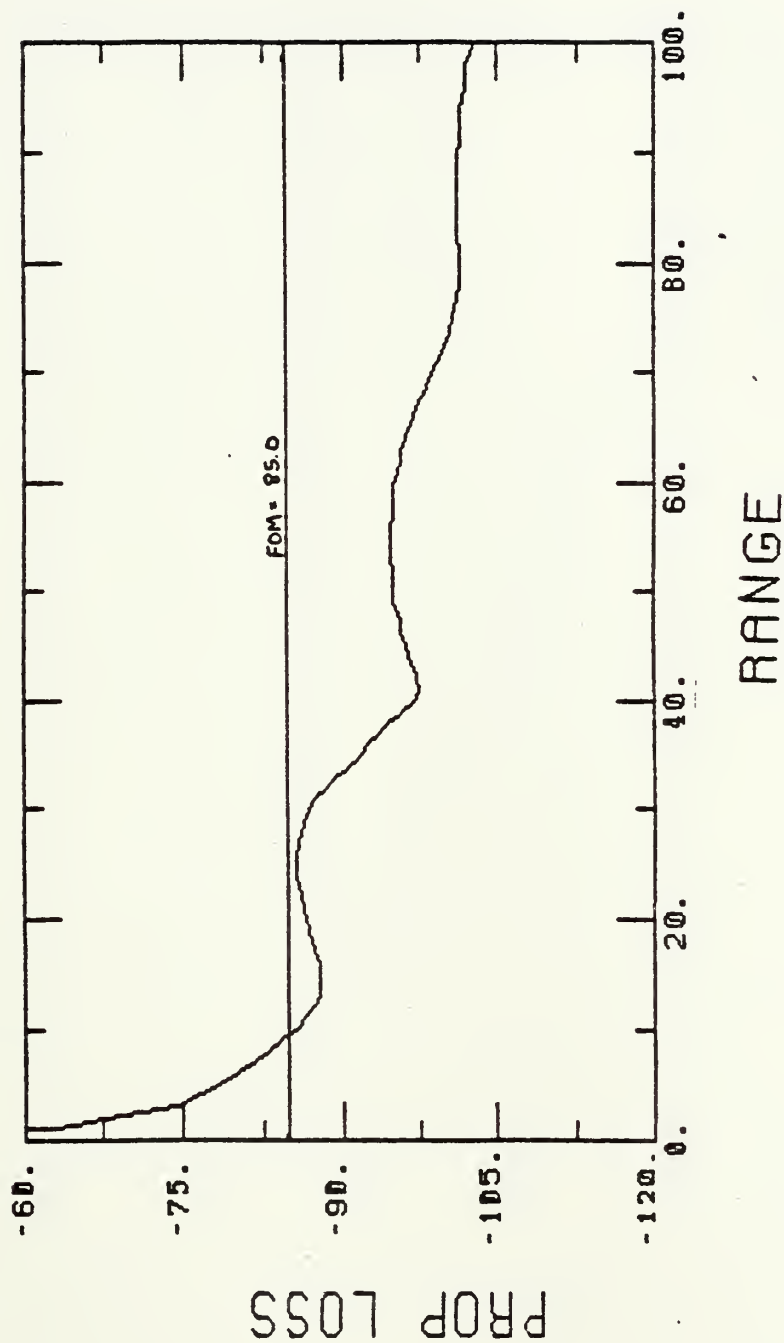
Figure 6-9. FOM vs. TL, 585 Hz, A123D Environment

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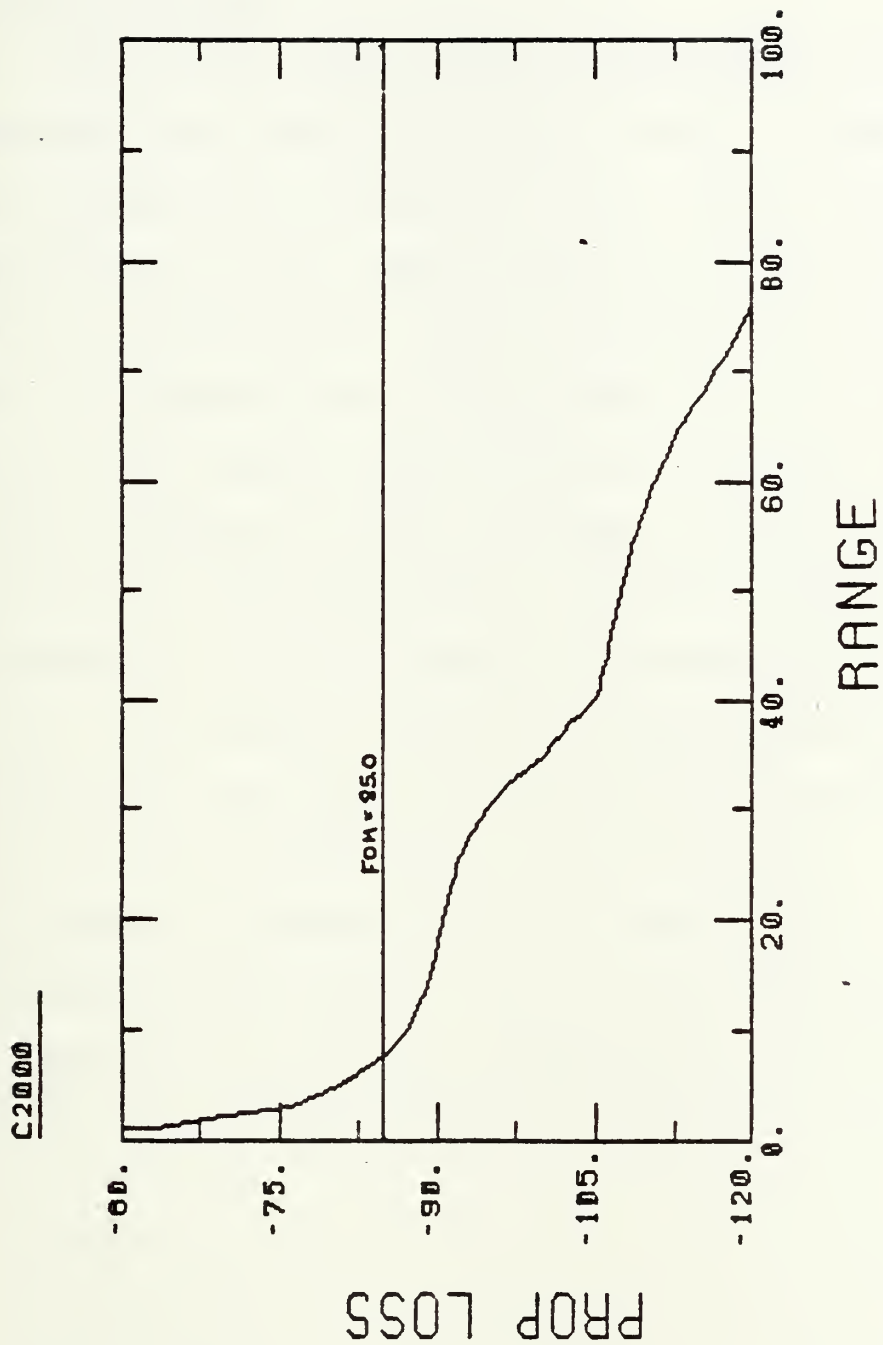
Figure 6-10. FOM vs. TL, Broadband Noise, A123D Environment

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purpose of tactical training. The operator can remedy the situation by adjusting the parameters to yield an FOM which will result in a desired 50 percent probability of detection range of detection.

For example, plot the desired range on the transmission loss curve as in Figure 6-11. A desired 50 percent probability of detection range of 5 NM yields a required FOM of 78 dB. Now the operator can determine which parameter in Equation 6-1 can be changed most readily to produce the desired FOM. In this case, the best choice is a parameter that affects only the 300 Hz narrowband signature detection, because the other two cases are satisfactory. The previously calculated FOM for the 300 Hz case was 92.4 dB, therefore, a -14.4 dB change is required to yield an FOM of 78 dB. This change can best be accomplished by modifying the noise level (NL) term. The previous NL was 85.6, and by adding 14.4 the desired results can be obtained. The NL is 100 dB and can be computed using an ambient noise of 100 dB. So, by changing the ambient noise in the environment file A123D from 85 dB to 100 dB, the operator is able to produce a desired 50 percent probability of detection range.
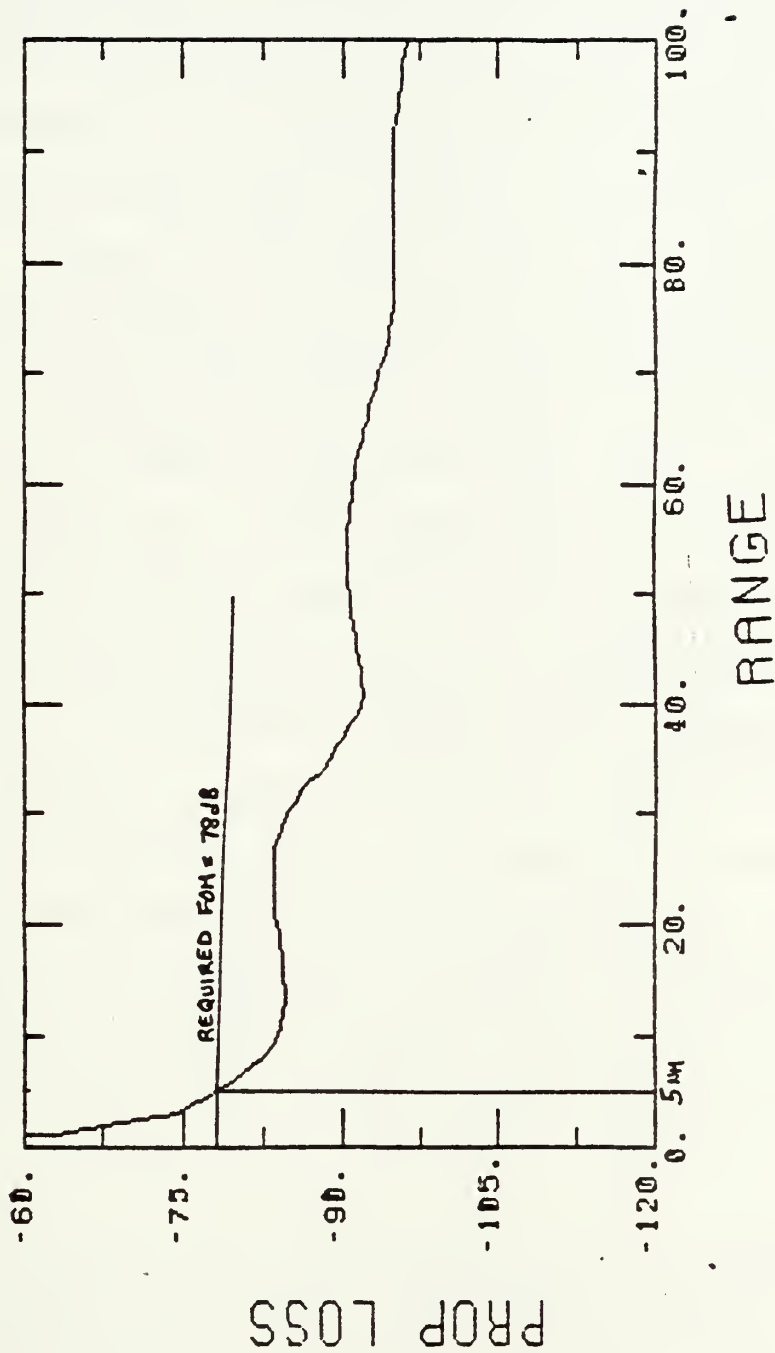
Figure 6-11. Required FOM for Desired Range of 5 NM

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VII.   CONCLUSIONS AND RECOMMENDATIONS

The objectives of this thesis were to document the passive sonar model in NWISS and to show its applications. In accomplishing these objectives it can be seen that the passive sonar model adds to NWISS's value as a tactical trainer. However, as discussed and as will be shown, the passive sonar model may lack the validity necessary to make it useful in the developmental research or analysis.

The way in which the passive sonar model is organized makes it useful as a tactics training aid. The equation used to compute signal excess is fairly simple, and the parameters in that equation are all readily accessible to the operator. This makes it possible for the operator to create a scenario to meet the training requirements. If the training requirements change, for instance, shorter detection ranges are desired, the operator can simply make adjustments to the database to reflect the changes. While this flexibility makes the passive sonar model valuable in a tactical training role, it also makes it difficult to validate.

It is primarily the organization of the database which makes validation difficult. The method of putting characteristic data into tables or lists, simplifies a

highly complex set of equations needed to model "real world" conditions. As examples, consider the values for directivity index, ambient noise, and narrowband target source level. The passive sonar model in NWISS uses a value for directivity index that is only a function of the bearing to the contact. In reality, the directivity index also depends on the frequency being detected. Ambient noise as listed in the environment file is only a function of frequency, but is also dependent on shipping density, weather, distance from shore, biologics, depth, and direction. The target source level used for narrowband frequency detection is not only a function of frequency but also a function of the speed of the target.

In conclusion, the passive sonar model adds to the value of NWISS as a tactical trainer, but in its present form, is limited in the use for developmental research or analysis. The continued use of the passive sonar model in NWISS for battle group tactical training provides a valuable asset for the fleet. The use of the passive sonar model for purposes of developmental research or analysis should be limited and any results should be carefully scrutinized.

The use of this thesis is recommended for anyone involved with the Naval Warfare Interactive Simulation System. It should be used to become familiar with the passive sonar model in order to prepare an ASW scenario, and

also to receive greater benefit from the training accomplished by NWISS. This thesis may also be used as a reference manual, and as an example to write reference manuals for the other models used in NWISS.

The applications of the passive sonar model to determine ranges of detection bring the following recommendations. With respect to the operator who is preparing a scenario, the use of figure of merit to determine range of detection gives an accurate representation of the capabilities of the sonar system modeled. Keeping the training requirements in mind, for example the ranges of detection desired, the operator can use the method described in Chapter VI to prepare the scenario to meet the training requirements. The player can similarly use the method described in Chapter VI to determine the expected ranges of detection and plan optimal tactics.

The applications of the passive sonar model described in Chapter VI is effective when used in simple scenarios such as one or two sensors versus one or two targets. For a more complex scenario such as a battle group training scenario, it is highly recommended that computer software be developed to accomplish the results of the applications described in Chapter VI.

APPENDIX A

NWISS ENVIRONMENT FILES

The purpose of this appendix is to familiarize the reader with how NWISS uses the environmental files. The addition of this appendix is due to the importance of the environment to passive sonar detection. The items discussed include: the creation of environment files, the review of environment files, the use of the environment files, and defining of sonar regions.

A. CREATION OF ENVIRONMENT FILES

In order to compile a set of usable environment files, the services of the Fleet Numerical Oceanographic Center (FNOC) in Monterey, California were solicited. It was desired that NWISS have the capability to offer the user a choice of environmental data corresponding to the area of operation, such as the ASW environmental zones for which FNOC provides prediction data. A request for the data necessary to create files for 42 ASW zones was sent to FNOC. The data for each zone was to be based on climatology for four months of the year, March, June, September, and December, so that 168 files would be created. The data for each zone provided by FNOC was edited, merged into a single source file, then processed by local programs at NOSC to generate an environment file compatible to NWISS.

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The resulting environment files were named according to the ASW zone and the month of the data provided. The first four characters of the filename indicate the ASW zone, while the fifth letter of the filename represents the month that the data applies to, i.e., M=March, J=June, S=September and D=December. The filetypes used include ENV, TAB, and TXT. Filetype ENV is used for the version of the file formatted for use by the computer during the game. This version is not readable. The TAB and TXT versions are capable of being read and edited. An example of an environment file would be A123D.ENV representing ASW zone A123 and using data corresponding to the month of December.

In addition to the original 168 environment files created from FNOC data, there are a few generic environment files available. These generic files were created by modifying one of the 168 original files. There are three of these generic files being used currently by IBGTT/CSF, they are: KGOOD.ENV, KFAIR.ENV, and KPOOR.ENV.

B. REVIEWING THE ENVIRONMENT FILES

The environment file in the ENV filetype format cannot be printed in readable format. To read the environment file the operator must use the command ENV/PRINT. The ENV/PRINT command will prompt the operator for the filename of the desired environment file and then create a new file with the identical filename but a new filetype. The new filetype is

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TAB. The new file, for example, A123D.TAB may then be printed, viewed on a monitor, and edited.

If the file is edited, in order for NWISS to use it in a game, the file must be changed into the operational code format (ENV filetype). To accomplish this, the operator must rename the file to change the filetype from TAB to TXT. This is done using the command RENAME <filename>.<filetype>. For example, RENAME A123D.TAB A123D.TXT.

The next step is to use the command ENV/BUILD. The ENV/BUILD command takes the environment file in the printable format with filetype TXT and creates a file in operational code with filetype ENV.

C. USE OF THE ENVIRONMENT FILES IN NWISS

Of the over 168 environment files available for use by NWISS a maximum of four can be utilized in one game. The environment files are selected by the operator based on the requirements for the scenario. Up to three of the environments can be defined by the logical names ENV$GOOD, ENV$FAIR, and ENV$POOR in the appropriate NWISS directory. The fourth is defined at game initialization as the default region environment. Each environment is given a number to be used in the assignment of a particular environment file to a sonar region. The environment file which defines ENV$GOOD is environment number one. The environment file which defines ENV$FAIR is environment number two. The

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environment which defines ENV$POOR is environment number three and the default region environment is environment number four.

D. DEFINING SONAR REGIONS

NWISS allows the operator to define up to 20 environmental sonar regions. This is accomplished in the FORCE process during game scenario preparation. A region must have at least three sides and no more than six sides.

The boundaries of the region are defined by latitude/ longitude position points. One point for each side of the region, i.e., a three sided sonar region would be defined by three lat/long positions, a four sided region by four lat/long positions, etc. The operator may define as many regions as required up to the limit of twenty. In addition, there is a default region automatically created which consists of all the area outside any of the defined sonar regions.

In defining a sonar region, the operator must also assign the environment to be used in that region. The operator has the choice of environment numbers one, two, or three, corresponding to the logical names ENV$GOOD, ENV$FAIR, ENV$POOR, respectively. The default region will automatically be assigned environment number four.

E. SAMPLE ENVIRONMENT FILES

The following pages are the environment files used in describing the passive sonar model and the applications discussed in Chapter VI.

TABLE A-1

ENVIRONMENT FILE = LGOOD ENV

SONIC LAYER DEPTH = 164 feet

NUMBER OF FREQUENCIES = 20

NUMBER OF ACTIVE SONOBUOYS = 3

NUMBER OF ACTIVE SONARS = 24

FREQUENCIES (Hz):

10	15	20	30	40	60	80	100	125	250	315	630	900	1250	1600	2000	2500	3500	5000	10000

AMBIENT NOISE (dB):

72	73	74	73	73	74	73	70	66	67	67	65	63	60	59	57	55	54	48	45

ACTIVE SONOBUOY DATA:

Type	Range (nautical miles)
SSQ47	2.00
SSQ50	3.00
SSQ62	3.00

ACTIVE SONAR DATA: (depth in feet, ranges in nautical miles)

Type	Dip/Tow Depth	DP Range 12 knots In	DP Range 12 knots Deep	DP Range 18 knots In	DP Range 18 knots Deep	DP Range 24 knots In	DP Range 24 knots Deep	BB Range Limits Inner	BB Range Limits Outer	BB Range Limits Inner	BB Range Limits Outer	CZ Limits Inner	CZ Limits Outer
AQS13	120	3.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARTIM	0	3.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BQQ5A	0	12.0	3.0	12.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0	31.0
BULLN	0	4.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BWOOD	0	2.0	1.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FENKM	0	3.0	2.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MARET	0	3.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MQ311	0	3.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEWCN	0	3.0	3.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OQS01	0	4.0	3.0	4.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OQS3	0	4.0	3.0	4.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OQS4	0	4.0	2.0	4.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PEQA2	0	2.0	2.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHRKF	0	3.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHRKT	0	3.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SQQ23	0	8.0	3.0	8.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	28.0	31.0
SQR26	0	4.0	3.0	4.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SQS23	0	3.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SQS26	0	12.0	3.0	12.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0	31.0
SQS35	170	1.0	2.0	1.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SQS53	0	12.0	3.0	12.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0	31.0
SQS56	0	5.0	3.0	5.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAMRS	0	2.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TMRI1	0	2.0	2.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A-1
(Continued)

PROPAGATION LOSS DATA: (all values in dB)

Mile	10 Hz In	Cross	Deep	15 Hz In	Cross	Deep	20 Hz In	Cross	Deep	30 Hz In	Cross	Deep	40 Hz In	Cross	Deep
1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1
2	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1
3	75.7	123.6	75.7	75.7	123.5	75.7	75.7	123.5	75.7	75.7	123.3	75.7	75.7	123.2	75.7
4	124.4	124.4	78.2	124.3	124.3	78.2	124.3	124.2	78.2	124.1	124.1	78.2	123.9	123.9	78.2
5	125.2	125.2	80.1	125.1	125.1	80.1	125.0	125.0	80.1	124.9	124.9	80.1	124.7	124.7	80.1
6	126.0	126.0	81.7	125.9	125.9	81.7	125.9	125.8	81.7	125.7	125.7	81.7	125.5	125.5	81.7
7	126.8	126.8	126.7	126.7	126.7	126.7	126.6	126.6	126.6	126.5	126.5	126.4	126.3	126.3	126.3
8	127.6	127.5	127.5	127.5	127.5	127.4	127.4	127.4	127.4	127.3	127.2	127.2	127.1	127.1	127.1
9	128.3	128.3	128.3	128.2	128.2	128.2	128.1	128.1	128.1	128.0	128.0	128.0	127.8	127.8	127.8
10	129.0	129.0	129.0	128.9	128.9	128.9	128.8	128.8	128.8	128.7	128.7	128.6	128.5	128.5	128.5
11	129.6	129.6	129.6	129.6	129.5	129.5	129.5	129.5	129.5	129.3	129.3	129.3	129.2	129.2	129.2
12	130.3	130.2	130.2	130.2	130.2	130.2	130.1	130.1	130.1	130.0	129.9	129.9	129.8	129.8	129.8
13	130.8	130.8	130.8	130.8	130.8	130.7	130.7	130.7	130.7	130.5	130.5	130.5	130.4	130.4	130.4
14	131.2	131.1	131.1	131.1	131.1	131.1	131.0	131.0	130.9	130.9	130.8	130.8	130.7	130.7	130.6
15	131.3	131.2	131.1	131.2	131.1	131.1	131.1	131.1	131.0	131.0	130.9	130.8	130.8	130.7	130.7
16	131.3	131.3	131.2	131.3	131.2	131.1	131.2	131.1	131.1	131.0	131.0	130.9	130.9	130.8	130.8
17	131.4	131.4	131.3	131.3	131.3	131.3	131.3	131.2	131.1	131.1	131.1	131.0	131.0	130.9	130.8
18	131.5	131.4	131.4	131.4	131.4	131.3	131.3	131.3	131.2	131.2	131.1	131.1	131.0	131.0	130.9
19	131.6	131.5	131.5	131.5	131.4	131.4	131.4	131.4	131.3	131.3	131.2	131.2	131.1	131.1	131.0
20	131.6	131.6	131.5	131.6	131.5	131.5	131.5	131.4	131.4	131.3	131.3	131.2	131.2	131.1	131.1
21	131.7	131.7	131.6	131.7	131.6	131.6	131.6	131.5	131.5	131.4	131.4	131.3	131.3	131.2	131.2
22	131.8	131.8	131.7	131.7	131.7	131.6	131.7	131.6	131.6	131.5	131.5	131.4	131.4	131.3	131.3
23	131.9	131.9	131.8	131.8	131.8	131.7	131.8	131.7	131.7	131.6	131.6	131.5	131.5	131.4	131.4
24	132.0	131.9	131.9	131.9	131.9	131.8	131.8	131.8	131.7	131.7	131.6	131.6	131.5	131.5	131.4
25	132.1	132.0	132.0	132.0	132.0	131.9	131.9	131.9	131.8	131.8	131.7	131.7	131.6	131.6	131.5
26	132.2	132.1	132.1	132.1	132.1	132.0	132.0	132.0	131.9	131.9	131.8	131.8	131.7	131.7	131.6
27	96.1	96.1	96.8	96.0	96.0	96.7	96.0	95.9	96.7	95.8	95.8	96.5	95.7	95.6	96.4
28	96.2	96.2	96.9	96.1	96.1	96.9	96.1	96.1	96.8	95.9	95.9	96.6	95.8	95.7	96.5
29	96.3	96.3	97.0	96.2	96.2	96.9	96.2	96.1	96.9	96.0	96.0	96.7	95.9	95.8	96.6
30	96.4	96.4	97.1	96.3	96.3	97.0	96.3	96.2	97.0	96.1	96.1	96.8	95.9	95.9	96.7
31	96.5	96.5	97.2	96.4	96.4	97.1	96.3	96.3	97.1	96.2	96.2	96.9	96.0	96.0	96.8
32	96.6	96.6	97.3	96.5	96.5	97.2	96.4	96.4	97.2	96.3	96.3	97.0	96.1	96.1	96.9
33	96.7	96.7	97.4	96.6	96.6	97.4	96.5	96.5	97.3	96.4	96.4	97.1	96.2	96.2	97.0
34	96.8	96.8	97.5	96.7	96.7	97.4	96.6	96.6	97.4	96.5	96.5	97.2	96.3	96.3	97.1
35	133.1	133.0	97.6	133.0	132.9	97.5	132.9	132.9	97.5	132.8	132.7	97.3	132.6	132.6	97.2
36	133.2	133.1	133.1	133.1	133.0	133.0	133.0	133.0	132.9	132.9	132.8	132.8	132.7	132.7	132.6
37	133.3	133.2	133.2	133.2	133.1	133.1	133.1	133.1	133.0	133.0	132.9	132.9	132.8	132.8	132.7
38	133.4	133.3	133.3	133.3	133.2	133.2	133.2	133.2	133.1	133.1	133.0	133.0	132.9	132.9	132.8
39	133.5	133.4	133.4	133.4	133.3	133.3	133.3	133.3	133.2	133.2	133.1	133.1	133.0	133.0	132.9
40	133.5	133.5	133.5	133.5	133.4	133.4	133.4	133.4	133.3	133.3	133.2	133.2	133.1	133.1	133.0
41	133.6	133.6	133.6	133.6	133.5	133.5	133.5	133.5	133.4	133.4	133.3	133.3	133.2	133.2	133.1
42	133.7	133.7	133.7	133.7	133.6	133.6	133.6	133.6	133.5	133.4	133.4	133.4	133.3	133.3	133.2
43	133.8	133.8	133.8	133.8	133.7	133.7	133.7	133.7	133.6	133.5	133.5	133.5	133.4	133.4	133.3
44	133.9	133.9	133.9	133.9	133.8	133.8	133.8	133.8	133.7	133.6	133.6	133.6	133.5	133.5	133.4
45	134.0	134.0	134.0	134.0	133.9	133.9	133.9	133.9	133.8	133.7	133.7	133.7	133.6	133.6	133.5
46	134.1	134.1	134.1	134.1	134.0	134.0	134.0	134.0	133.9	133.8	133.8	133.8	133.7	133.7	133.6
47	134.2	134.2	134.2	134.2	134.1	134.1	134.1	134.1	134.0	133.9	133.9	133.9	133.8	133.8	133.7
48	134.3	134.3	134.3	134.3	134.2	134.2	134.2	134.2	134.1	134.0	134.0	134.0	133.9	133.9	133.8
49	134.4	134.4	134.4	134.4	134.3	134.3	134.3	134.2	134.2	134.1	134.1	134.1	134.0	134.0	133.9
50	134.5	134.5	134.5	134.4	134.4	134.4	134.4	134.3	134.3	134.2	134.2	134.2	134.1	134.0	134.0
51	134.6	134.6	134.6	134.5	134.5	134.5	134.5	134.4	134.4	134.3	134.3	134.3	134.2	134.1	134.1
52	134.7	134.7	134.7	134.6	134.6	134.6	134.6	134.5	134.5	134.4	134.4	134.4	134.3	134.2	134.2
53	98.6	98.6	99.4	98.6	98.5	99.3	98.5	98.5	99.2	98.3	98.3	99.1	98.2	98.2	98.9
54	98.7	98.7	99.5	98.7	98.6	99.4	98.6	98.6	99.3	98.4	98.4	99.2	98.3	98.3	99.0
55	98.8	98.8	99.6	98.8	98.7	99.5	98.7	98.7	99.4	98.5	98.5	99.3	98.4	98.4	99.1
56	98.9	98.9	99.7	98.8	98.8	99.6	98.8	98.7	99.5	98.6	98.6	99.4	98.5	98.4	99.2
57	99.0	99.0	99.7	98.9	98.9	99.7	98.9	98.8	99.6	98.7	98.7	99.5	98.6	98.5	99.3
58	99.1	99.1	99.8	99.0	99.0	99.8	99.0	98.9	99.7	98.8	98.8	99.5	98.7	98.6	99.4
59	99.2	99.2	99.9	99.1	99.1	99.9	99.0	99.0	99.8	98.9	98.9	99.6	98.7	98.7	99.5
60	99.3	99.3	100.0	99.2	99.2	99.9	99.1	99.1	99.9	99.0	99.0	99.7	98.8	98.8	99.6

97

61	99.4	99.3	100.1	99.3	99.3	100.0	99.2	99.2	100.0	99.1	99.0	99.8	98.9	98.9	99.7
62	135.6	135.6	135.6	135.5	135.5	135.5	135.5	135.4	135.4	135.3	135.3	135.3	135.2	135.1	135.1
63	135.7	135.7	135.7	135.6	135.6	135.6	135.6	135.5	135.5	135.4	135.4	135.4	135.3	135.2	135.2
64	135.8	135.8	135.7	135.7	135.7	135.7	135.6	135.6	135.6	135.5	135.5	135.4	135.3	135.3	135.3
65	135.9	135.8	135.8	135.8	135.8	135.8	135.7	135.7	135.7	135.6	135.6	135.5	135.4	135.4	135.4
66	136.0	135.9	135.9	135.9	135.9	135.9	135.8	135.8	135.8	135.7	135.6	135.6	135.5	135.5	135.5
67	136.0	136.0	136.0	136.0	135.9	135.9	135.9	135.9	135.8	135.7	135.7	135.7	135.6	135.6	135.6
68	136.1	136.1	136.1	136.1	136.0	136.0	136.0	136.0	135.9	135.8	135.8	135.8	135.7	135.7	135.6
69	136.2	136.2	136.2	136.1	136.1	136.1	136.1	136.0	136.0	135.9	135.9	135.9	135.8	135.7	135.7
70	136.3	136.3	136.2	136.2	136.2	136.2	136.1	136.1	136.1	136.0	136.0	136.0	135.9	135.8	135.8
71	136.4	136.4	136.3	136.3	136.3	136.3	136.2	136.2	136.2	136.1	136.1	136.0	135.9	135.9	135.9
72	136.5	136.4	136.4	136.4	136.4	136.3	136.3	136.3	136.3	136.2	136.1	136.1	136.0	136.0	136.0
73	136.5	316.5	136.5	136.5	136.4	136.4	136.4	136.4	136.3	136.2	136.2	136.2	136.1	136.1	136.1
74	136.6	136.6	136.6	136.5	136.5	136.5	136.5	136.5	136.4	136.3	136.3	136.3	136.2	136.2	136.1
75	136.7	136.7	136.7	136.6	136.6	136.6	136.5	136.5	136.5	136.4	136.4	136.4	136.3	136.2	136.2
76	136.8	136.8	136.7	136.7	136.7	136.7	136.6	136.6	136.6	136.5	136.5	136.4	136.3	136.3	136.3
77	136.9	136.8	136.8	136.8	136.8	136.7	136.7	136.7	136.7	136.6	136.6	136.5	136.4	136.4	136.4
78	136.9	136.9	136.9	136.9	136.8	136.8	136.8	136.8	136.7	136.6	136.6	136.6	136.5	136.5	136.5
79	137.0	137.0	137.0	136.9	136.9	136.9	136.9	136.8	136.8	136.7	136.7	136.7	136.6	136.6	136.5
80	137.1	137.1	137.0	137.0	137.0	137.0	136.9	136.9	136.9	136.8	136.8	136.8	136.6	136.6	136.6
81	137.2	137.1	137.1	137.1	137.1	137.0	137.0	137.0	137.0	136.9	136.8	136.8	136.7	136.7	136.7
82	137.2	137.2	137.2	137.2	137.1	137.1	137.1	137.1	137.0	136.9	136.9	136.9	136.8	136.8	136.8
83	137.3	137.3	137.3	137.2	137.2	137.2	137.2	137.1	137.1	137.0	137.0	137.0	136.9	136.9	136.8
84	137.4	137.4	137.3	137.3	137.3	137.3	137.2	137.2	137.2	137.1	137.1	137.1	136.9	136.9	136.9
85	137.5	137.4	137.4	137.4	137.4	137.3	137.3	137.3	137.3	137.2	137.1	137.1	137.0	137.0	137.0
86	137.5	137.5	137.5	137.5	137.4	137.4	137.4	137.4	137.3	137.2	137.2	137.2	137.1	137.1	137.1
87	137.6	137.6	137.6	137.5	137.5	137.5	137.5	137.4	137.4	137.3	137.3	137.3	137.2	137.2	137.1
88	137.7	137.7	137.6	137.6	137.6	137.6	137.5	137.5	137.5	137.4	137.4	137.3	137.2	137.2	137.2
89	137.7	137.7	137.7	137.7	137.7	137.6	137.6	137.6	137.6	137.5	137.4	137.4	137.3	137.3	137.3
90	137.8	137.8	137.8	137.7	137.7	137.7	137.7	137.7	137.6	137.5	137.5	137.5	137.4	137.4	137.3
91	137.9	137.9	137.9	137.8	137.8	137.8	137.7	137.7	137.7	137.6	137.6	137.6	137.5	137.4	137.4
92	138.0	137.9	137.9	137.9	137.9	137.8	137.8	137.8	137.8	137.7	137.7	137.6	137.5	137.5	137.5
93	138.0	138.0	138.0	138.0	137.9	137.9	137.9	137.9	137.8	137.7	137.7	137.7	137.6	137.6	137.6
94	138.1	138.1	138.1	138.0	138.0	138.0	137.9	137.9	137.9	137.8	137.8	137.8	137.7	137.6	137.6
95	138.2	138.1	138.1	138.1	138.1	138.1	138.0	138.0	138.0	137.9	137.9	137.8	137.7	137.7	137.7
96	138.2	138.2	138.2	138.2	138.1	138.1	138.1	138.1	138.1	137.9	137.9	137.9	137.8	138.8	137.8
97	138.3	138.3	138.3	138.2	138.2	138.2	138.2	138.1	138.1	138.0	138.0	138.0	137.9	137.9	137.8
98	138.4	138.3	138.3	138.3	138.3	138.3	138.2	138.2	138.2	138.1	138.1	138.0	137.9	137.9	137.9
99	138.4	138.4	138.4	138.4	138.3	138.3	138.3	138.3	138.3	138.1	138.1	138.1	138.0	138.0	138.0
100	138.5	138.5	138.5	138.4	138.4	138.4	138.4	138.3	138.3	138.2	138.2	138.2	138.1	138.1	138.0
101	138.6	138.5	138.5	138.5	138.5	138.5	138.4	138.4	138.4	138.3	138.3	138.2	138.1	138.1	138.1
102	138.6	138.6	138.6	138.6	138.5	138.5	138.5	138.5	138.5	138.3	138.3	138.3	138.2	138.2	138.2
103	138.7	138.7	138.7	138.6	138.6	138.6	138.5	138.5	138.5	138.4	138.4	138.4	138.3	138.3	138.2
104	138.8	138.7	138.7	138.7	138.7	138.7	138.6	138.6	138.6	138.5	138.5	138.4	138.3	138.3	138.3
105	138.8	138.8	138.8	138.7	138.7	138.7	138.7	138.7	138.7	138.5	138.5	138.5	138.4	138.4	138.4
106	138.9	138.9	138.9	138.8	138.8	138.8	138.7	138.7	138.7	138.6	138.6	138.6	138.5	138.4	138.4
107	138.9	138.9	138.9	138.9	138.9	138.8	138.8	138.8	138.8	138.7	138.6	138.6	138.5	138.5	138.5
108	139.0	139.0	139.0	138.9	138.9	139.0	138.9	138.9	138.8	138.7	138.7	138.7	138.6	138.6	138.6
109	139.1	139.1	139.0	139.0	139.0	139.0	138.9	138.9	138.9	138.8	138.8	138.8	138.6	138.6	138.6
110	139.1	139.1	139.1	139.1	139.0	139.0	139.0	139.0	139.0	138.8	138.8	138.8	138.7	138.7	138.7
111	139.2	139.2	139.2	139.1	139.1	139.1	139.1	139.0	139.0	138.9	138.9	138.9	138.8	138.8	138.7
112	139.3	139.2	139.2	139.2	139.2	139.2	139.1	139.1	139.1	139.0	139.0	138.9	138.8	138.8	138.8
113	139.3	139.3	139.3	139.2	139.2	139.2	139.2	139.2	139.1	139.0	139.0	139.0	138.8	138.9	138.9
114	139.4	139.4	139.4	139.3	139.3	139.3	139.2	139.2	139.2	139.1	139.1	139.1	139.0	138.9	138.9
115	139.4	139.4	139.4	139.4	139.4	139.3	139.3	139.3	139.3	139.2	139.1	139.1	139.0	139.0	139.0
116	139.5	139.5	139.5	139.4	139.4	139.4	139.4	139.3	139.3	139.2	139.2	139.2	139.1	139.1	139.0
117	139.5	139.5	139.5	139.5	139.5	139.5	139.4	139.4	139.4	139.3	139.3	139.2	139.1	139.1	139.1
118	139.6	139.6	139.6	139.5	139.5	139.5	139.5	139.5	139.4	139.3	139.3	139.3	139.2	139.2	139.2
119	139.7	139.7	139.6	139.6	139.6	139.6	139.5	139.5	139.5	139.4	139.4	139.4	139.2	139.2	139.2
120	139.7	139.7	139.7	139.7	139.6	139.6	139.6	139.6	139.6	139.4	139.4	139.4	139.3	139.3	139.3

Mile	60 Hz			80 Hz			100 Hz			125 Hz			250 Hz		
	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep
1	66.1	66.1	66.1	66.0	66.1	66.1	65.7	66.1	66.1	65.2	66.1	66.1	63.6	66.1	66.1
2	72.2	72.2	72.2	72.1	72.2	72.2	72.1	72.2	72.2	71.8	72.2	72.2	69.5	72.2	72.2
3	75.7	122.8	75.7	75.7	122.5	75.7	75.7	122.2	75.7	75.6	121.7	75.7	73.4	120.7	75.7
4	123.6	123.6	78.2	123.0	123.3	78.2	114.2	122.9	78.2	101.3	122.5	78.2	81.3	121.5	78.2
5	124.4	124.4	80.1	124.1	124.1	80.1	122.0	123.7	80.1	109.9	123.3	80.1	85.0	122.3	80.2
6	125.2	125.2	81.7	124.9	124.9	81.7	124.4	124.5	81.7	117.5	124.1	81.7	88.5	123.1	81.8
7	126.0	126.0	126.0	125.7	125.7	125.6	125.3	125.3	125.3	122.8	124.9	124.9	91.9	123.9	123.9
8	126.8	126.8	126.7	126.5	126.4	126.4	126.1	126.1	126.1	125.2	125.7	125.6	95.2	124.7	124.7
9	127.5	127.5	127.5	127.2	127.2	127.2	126.8	126.8	126.8	126.3	126.4	126.4	98.4	125.5	125.4
10	128.2	128.2	128.2	127.9	127.9	127.9	127.5	127.5	127.5	127.1	127.1	127.1	101.6	126.2	126.1
11	128.9	128.9	128.8	128.5	128.5	128.5	128.2	128.2	128.2	127.8	127.7	127.7	104.7	126.8	126.8
12	129.5	129.5	129.5	129.2	129.1	129.1	128.8	128.8	128.8	128.4	128.4	128.4	107.8	127.5	127.4
13	130.1	130.1	130.1	129.7	129.7	129.7	129.4	129.4	129.4	129.0	129.0	129.0	110.8	128.1	128.0
14	130.4	130.4	130.3	130.1	130.0	130.0	129.8	129.7	129.6	129.3	129.3	129.2	113.8	128.6	128.6
15	130.5	130.4	130.4	130.2	130.1	130.1	129.8	129.8	129.7	129.4	129.3	129.3	116.7	129.2	129.2
16	130.6	130.5	130.5	130.2	130.2	130.1	129.9	129.9	129.8	129.5	129.4	129.4	119.5	129.7	129.7
17	130.6	130.6	130.5	130.3	130.3	130.2	130.0	129.9	129.9	129.6	129.5	129.4	122.2	130.2	130.2
18	130.7	130.7	130.6	130.4	130.3	130.3	130.1	130.0	130.0	129.6	129.6	129.5	124.6	130.6	130.6
19	130.8	130.7	130.7	130.5	130.4	130.4	130.1	130.1	130.0	129.7	129.7	129.6	126.8	131.1	131.1
20	130.9	130.8	130.8	130.6	130.5	130.5	130.2	130.2	130.1	129.8	129.7	129.7	128.6	131.5	131.5
21	131.0	130.9	130.9	130.6	130.6	130.5	130.3	130.3	130.2	129.9	129.8	129.8	130.1	131.9	131.9
22	131.1	131.0	131.0	130.7	130.7	130.6	130.4	130.4	130.3	130.0	129.9	129.9	131.2	132.3	132.3
23	131.1	131.1	131.0	130.8	130.8	130.7	130.5	130.4	130.4	130.1	130.0	130.0	132.0	132.7	132.7
24	131.2	131.2	131.1	130.9	130.9	130.8	130.6	130.5	130.5	130.2	130.1	130.1	132.7	133.0	133.0
25	131.3	131.3	131.2	131.0	131.0	130.9	130.7	130.6	130.6	130.3	130.2	130.2	133.2	133.4	133.4
26	131.4	131.4	131.3	131.1	131.1	131.0	130.8	130.7	130.7	130.3	130.3	130.3	133.6	133.7	133.7
27	95.4	95.3	96.1	95.0	95.0	95.7	94.7	94.7	95.4	94.3	94.2	95.0	97.8	97.9	98.7
28	95.4	95.4	96.2	95.1	95.1	95.8	94.8	94.8	95.5	94.4	94.3	95.1	98.2	98.2	99.0
29	95.5	99.5	96.2	95.2	95.2	95.9	94.9	94.9	95.6	94.5	94.4	95.2	98.5	98.5	99.3
30	95.6	95.6	96.3	95.3	95.3	96.0	95.0	95.0	95.7	94.6	94.5	95.3	98.8	98.8	99.6
31	95.7	95.7	96.4	95.4	95.4	96.1	95.1	95.1	95.8	94.7	94.6	95.4	98.8	98.7	99.4
32	95.8	95.8	96.5	95.5	95.5	96.2	95.2	95.2	95.9	94.8	94.7	95.5	98.7	98.6	99.3
33	95.9	95.9	96.7	95.6	95.6	96.3	95.3	95.3	96.0	94.9	94.8	95.6	98.6	98.5	99.2
34	96.0	96.0	96.8	95.7	95.7	96.4	95.4	95.4	96.1	95.0	94.9	95.7	98.5	98.4	99.1
35	132.3	132.2	96.9	132.0	131.9	96.5	131.7	131.6	96.2	131.3	131.2	95.8	134.6	134.5	99.0
36	132.4	132.4	132.3	132.1	132.0	132.0	131.8	131.7	131.7	131.4	131.3	131.3	134.5	134.4	134.3
37	132.5	132.5	132.4	132.2	132.1	132.1	131.9	131.8	131.8	131.5	131.4	131.4	134.4	134.3	134.2
38	132.6	132.6	132.5	132.3	132.3	132.2	132.0	131.9	131.9	131.6	131.5	131.5	134.3	134.2	134.2
39	132.7	132.7	132.6	132.4	132.4	132.3	132.1	132.0	132.0	131.7	131.6	131.6	134.3	134.2	134.1
40	132.8	132.8	132.7	132.5	132.5	132.4	132.2	132.1	132.1	131.8	131.7	131.7	134.2	134.1	134.1
41	132.9	132.9	132.8	132.6	132.6	132.5	132.3	132.2	132.2	131.9	131.8	131.8	134.2	134.1	134.0
42	133.0	133.0	132.9	132.7	132.7	132.6	132.4	132.3	132.3	132.0	131.9	131.9	134.1	134.1	134.0
43	133.1	133.1	133.0	132.8	132.8	132.7	132.5	132.4	132.4	132.1	132.0	132.0	134.1	134.0	133.9
44	133.2	133.2	133.1	132.9	132.9	132.8	132.6	132.5	132.5	132.2	132.1	132.1	134.1	134.0	133.9
45	133.3	133.3	133.2	133.0	133.0	132.9	132.7	132.6	132.6	132.3	132.2	132.2	134.0	134.0	133.9
46	133.4	133.4	133.3	133.1	133.1	133.0	132.8	132.7	132.7	132.4	132.3	132.3	134.0	134.0	133.9
47	133.5	133.5	133.4	133.2	133.2	133.1	132.9	132.8	132.8	132.5	132.4	132.4	134.0	133.9	133.9
48	133.6	133.6	133.5	133.3	133.2	133.2	133.0	132.9	132.9	132.6	132.5	132.5	134.0	133.9	133.9
49	133.7	133.7	133.6	133.4	133.3	133.3	133.1	133.0	133.0	132.7	132.6	132.6	134.0	133.9	133.9
50	133.8	133.7	133.7	133.5	133.4	133.4	133.2	133.1	133.1	132.8	132.7	132.7	134.0	133.9	133.9
51	133.9	133.8	133.8	133.6	133.5	133.5	133.3	133.2	133.2	132.9	132.8	132.8	134.0	133.9	133.9
52	134.0	133.9	133.9	133.7	133.6	133.6	133.4	133.3	133.3	133.0	132.9	132.9	134.0	133.9	133.9
53	97.9	97.9	98.6	97.6	97.6	98.3	97.3	97.3	98.0	96.9	96.9	97.6	97.8	97.8	98.5
54	98.0	98.0	98.8	97.7	97.7	98.4	97.4	97.4	98.1	97.0	97.0	97.7	97.9	97.8	98.5
55	98.1	98.1	98.8	97.8	97.8	98.5	97.5	97.4	98.2	97.1	97.1	97.8	97.9	97.8	98.5
56	98.2	98.1	98.9	97.9	97.8	98.6	97.6	97.5	98.3	97.2	97.2	97.9	97.9	97.8	98.6
57	98.3	98.2	99.0	98.0	97.9	98.7	97.7	97.6	98.4	97.3	97.2	98.0	97.9	97.8	98.6

58	98.4	98.3	99.1	98.1	98.0	98.8	97.8	97.7	98.5	97.4	97.3	98.1	97.9	97.9	98.6
59	98.4	98.4	99.2	98.1	98.1	98.9	97.8	97.8	98.6	97.5	97.4	98.2	97.9	97.9	98.6
60	98.5	98.5	99.3	98.2	98.2	99.0	97.9	97.9	98.7	97.5	97.5	98.3	98.0	97.9	98.6
61	98.6	98.6	99.4	98.3	98.3	99.1	98.0	98.0	99.1	97.6	97.6	98.4	98.0	97.9	98.7
62	134.9	134.9	134.8	134.6	134.6	134.5	134.3	134.3	134.2	133.9	133.9	133.8	134.2	134.1	134.1
63	135.0	134.9	134.9	134.7	134.6	134.6	134.4	134.3	134.3	134.0	134.0	133.9	134.2	134.1	134.1
64	135.1	135.0	135.0	134.8	134.7	134.7	134.5	134.4	134.4	134.1	134.0	134.0	134.2	134.2	134.1
65	135.1	135.1	135.1	134.8	134.8	134.8	134.5	134.5	134.5	134.2	134.1	134.1	134.3	134.2	134.2
66	135.2	135.2	135.2	134.9	134.9	134.9	134.6	134.6	134.6	134.2	134.2	134.2	134.3	134.2	134.2
67	135.3	135.3	135.3	135.0	135.0	135.0	134.7	134.7	134.7	134.3	134.3	134.3	134.3	134.3	134.2
68	135.4	135.4	135.3	135.1	135.1	135.1	134.8	134.8	134.8	134.4	134.4	134.4	134.4	134.3	134.3
69	135.5	135.5	135.4	135.2	135.2	135.1	134.9	134.9	134.8	134.5	134.5	134.5	134.4	134.3	134.3
70	135.6	135.5	135.5	135.3	135.2	135.2	135.0	134.9	134.9	134.6	134.6	134.6	134.4	134.4	134.3
71	135.6	135.6	135.6	135.3	135.3	135.3	135.1	135.0	135.0	134.7	134.7	134.6	134.5	134.4	134.4
72	135.7	135.7	135.7	135.4	135.4	135.4	135.1	135.1	135.1	134.8	134.7	134.7	134.5	134.4	134.4
73	135.8	135.8	135.8	135.5	135.5	135.5	135.2	135.2	135.2	134.8	134.8	134.8	134.5	134.5	134.4
74	135.9	135.9	135.8	135.6	135.6	135.6	135.3	135.3	135.3	134.9	134.9	134.9	134.6	134.5	134.5
75	136.0	135.9	135.9	135.7	135.7	135.6	135.4	135.4	135.3	135.0	135.0	135.0	134.6	134.6	134.5
76	136.0	136.0	136.0	135.8	135.7	135.7	135.5	135.4	135.4	135.1	135.1	135.1	134.7	134.6	134.6
77	136.1	136.1	136.1	135.8	135.8	135.8	135.5	135.5	135.5	135.2	135.2	135.1	134.7	134.7	134.6
78	136.2	136.2	136.2	135.9	135.9	135.9	135.6	135.6	135.6	135.3	135.2	135.2	134.7	134.7	134.7
79	136.3	136.3	136.2	136.0	136.0	136.0	135.7	135.7	135.7	135.3	135.3	135.3	134.8	134.7	134.7
80	136.4	136.3	136.3	136.1	136.1	136.0	135.8	135.8	135.7	135.4	135.4	135.4	134.8	134.8	134.7
81	136.4	136.4	136.4	136.1	136.1	136.1	135.9	135.8	135.8	135.5	135.5	135.5	134.9	134.8	134.8
82	136.5	136.5	136.5	136.2	136.2	136.2	135.9	135.9	135.9	135.6	135.6	135.5	134.9	134.9	134.8
83	136.6	136.6	136.5	136.3	136.3	136.3	136.0	136.0	136.0	135.7	135.6	135.6	135.0	134.9	134.9
84	136.7	136.6	136.6	136.4	136.4	136.3	136.1	136.1	136.1	135.7	135.7	135.7	135.0	135.0	134.9
85	136.7	136.7	136.7	136.4	136.4	136.4	136.2	136.1	136.1	135.8	135.8	135.8	135.1	135.0	135.0
86	136.8	136.8	136.8	136.5	136.5	136.5	136.2	136.2	136.2	135.9	135.9	135.8	135.1	135.1	135.0
87	136.9	136.9	136.8	136.6	136.6	136.6	136.3	136.3	136.3	136.0	135.9	135.9	135.1	135.1	135.1
88	137.0	136.9	136.9	136.7	136.7	136.6	136.4	136.4	136.4	136.0	136.0	136.0	135.2	135.2	135.1
89	137.0	137.0	137.0	136.7	136.7	136.7	136.5	136.4	136.4	136.1	136.1	136.1	135.2	135.2	135.2
90	137.1	137.1	137.1	136.8	136.8	136.8	136.5	136.5	136.5	136.2	136.2	136.1	135.3	135.2	135.2
91	137.2	137.2	137.1	136.9	136.9	136.9	136.6	136.6	136.6	136.3	136.2	136.2	135.3	135.3	135.3
92	137.2	137.2	137.2	137.0	136.9	136.9	136.7	136.7	136.6	136.3	136.3	136.3	135.4	135.3	135.3
93	137.3	137.3	137.3	137.0	137.0	137.0	136.7	136.7	136.7	136.4	136.4	136.4	135.4	135.4	135.4
94	137.4	137.4	137.3	137.1	137.1	137.1	136.8	136.8	136.8	136.5	136.5	136.4	135.5	135.4	135.4
95	137.4	137.4	137.4	137.2	137.2	137.1	136.9	136.9	136.9	136.5	136.5	136.5	135.5	135.5	135.4
96	137.5	137.5	137.5	137.2	137.2	137.2	137.0	136.9	136.9	136.6	136.6	136.6	135.6	135.5	135.5
97	137.6	137.6	137.6	137.3	137.3	137.3	137.0	137.0	137.0	136.7	136.7	136.7	135.6	135.6	135.5
98	137.7	137.6	137.6	137.4	137.4	137.3	137.1	137.1	137.1	136.8	136.7	136.7	135.7	135.6	135.6
99	137.7	137.7	137.7	137.4	137.4	137.4	137.2	137.2	137.1	136.8	136.8	136.8	135.7	135.7	135.6
100	137.8	137.8	137.8	137.5	137.5	137.5	137.2	137.2	137.2	136.9	136.9	136.9	135.8	135.7	135.7
101	137.9	137.8	137.8	137.6	137.6	137.5	137.3	137.3	137.3	137.0	136.9	136.9	135.8	135.8	135.7
102	137.9	137.9	137.9	137.6	137.6	137.6	137.4	137.4	137.3	137.0	137.0	137.0	135.9	135.8	135.8
103	138.0	138.0	138.0	137.7	137.7	137.7	137.4	137.4	137.4	137.1	137.1	137.1	135.9	135.9	135.8
104	138.0	138.0	138.0	137.8	137.8	137.8	137.5	137.5	137.5	137.2	137.2	137.1	136.0	135.9	135.9
105	138.1	138.1	138.1	137.8	137.8	137.8	137.6	137.6	137.5	137.2	137.2	137.2	136.0	136.0	135.9
106	138.2	138.2	138.2	137.9	137.9	137.9	137.6	137.6	137.6	137.3	137.3	137.3	136.1	136.0	136.0
107	138.2	138.2	138.2	138.0	138.0	137.9	137.7	137.7	137.7	137.4	137.4	137.3	136.1	136.1	136.0
108	138.3	138.3	138.3	138.0	138.0	138.0	137.8	137.8	137.7	137.4	137.4	137.4	136.2	136.1	136.1
109	138.4	138.4	138.3	138.1	138.1	138.1	137.8	137.8	137.8	137.5	137.5	137.5	136.2	136.2	136.1
110	138.4	138.4	138.4	138.2	138.1	138.1	137.9	137.9	137.9	137.6	137.5	137.5	136.3	136.2	136.2
111	138.5	138.5	138.5	138.2	138.2	138.2	138.0	137.9	137.9	137.6	137.6	137.6	136.3	136.3	136.2
112	138.6	138.5	138.5	138.3	138.3	138.3	138.0	138.0	138.0	137.7	137.7	137.7	136.4	136.3	136.3
113	138.6	138.6	138.6	138.3	138.3	138.3	138.1	138.1	138.1	137.8	137.7	137.7	136.4	136.4	136.3
114	138.7	138.7	138.7	138.4	138.4	138.4	138.1	138.1	138.1	137.8	137.8	137.8	136.5	136.4	136.4
115	138.7	138.7	138.7	138.5	138.5	138.4	138.2	138.2	138.2	137.9	137.9	137.9	136.5	136.5	136.5
116	138.8	138.8	138.8	138.5	138.5	138.5	138.3	138.3	138.2	137.9	137.9	137.9	136.6	136.6	136.6
117	138.9	138.8	138.8	138.6	138.6	138.6	138.3	138.3	138.3	138.0	138.0	138.0	136.7	136.7	136.7
118	138.9	138.9	138.9	138.7	138.6	138.6	138.4	138.4	138.4	138.1	138.1	138.0	136.8	136.8	136.8
119	139.0	139.0	139.0	138.7	138.7	138.7	138.4	138.4	138.4	138.1	138.1	138.1	136.9	136.9	136.9
120	139.0	139.0	139.0	138.8	138.8	138.7	138.5	138.5	138.5	138.2	138.2	138.2	136.9	126.9	136.9

	315 Hz			630 Hz			900 Hz			1250 Hz			1600 Hz		
Mile	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep
1	66.3	66.1	66.1	66.2	66.2	66.2	66.2	66.2	66.2	66.3	66.3	66.3	66.3	66.3	66.3
2	68.8	72.2	72.2	72.3	72.3	72.3	72.3	72.3	72.3	72.4	72.4	72.4	72.4	72.4	72.4
3	72.4	120.8	75.7	75.8	121.0	75.8	75.9	120.9	75.9	76.0	136.5	76.0	76.1	136.6	76.1
4	78.5	121.5	78.2	121.8	121.8	78.4	121.8	121.7	78.5	137.4	137.3	78.7	137.5	137.5	78.7
5	81.4	122.4	80.2	122.7	122.6	80.6	122.6	122.6	80.6	138.2	138.2	80.7	138.4	138.4	80.8
6	84.2	123.2	81.8	123.5	123.5	82.0	123.5	123.4	82.2	139.1	139.1	82.4	139.3	139.3	82.6
7	86.9	124.0	124.0	124.4	124.3	124.3	124.3	124.3	124.3	140.0	140.0	140.0	140.2	140.2	140.2
8	89.5	124.8	124.8	125.2	125.1	125.1	125.2	125.1	125.1	140.9	140.9	140.8	141.1	141.1	141.0
9	92.1	125.5	125.5	125.9	125.9	125.9	126.0	126.0	125.9	141.7	141.7	141.7	141.9	141.9	141.9
10	94.5	126.2	126.2	126.7	126.7	126.7	126.7	126.7	126.7	142.5	142.5	142.5	142.8	142.7	142.7
11	96.9	126.9	126.9	127.4	127.4	127.4	127.5	127.5	127.5	143.3	143.3	143.2	143.5	143.5	143.5
12	99.3	127.5	127.5	128.1	128.0	128.0	128.2	128.2	128.2	144.0	144.0	144.0	144.3	144.3	144.3
13	101.7	128.1	128.1	128.7	128.7	128.7	128.8	128.8	128.8	144.7	144.7	144.7	145.0	145.0	145.0
14	104.0	128.7	128.7	129.3	129.3	129.3	129.5	129.5	129.5	145.4	145.4	145.3	145.7	145.7	145.7
15	106.3	129.3	129.3	129.9	129.9	129.9	130.1	130.1	130.1	146.0	146.0	146.0	146.3	146.3	146.3
16	108.6	129.8	129.8	130.4	130.4	130.4	130.7	130.7	130.7	146.6	146.6	146.6	147.0	147.0	147.0
17	110.9	130.3	130.3	131.0	131.0	131.0	131.2	131.2	131.2	147.2	147.2	147.2	147.6	147.6	147.6
18	113.1	130.7	130.7	131.5	131.5	131.5	131.8	131.8	131.8	147.8	147.8	147.8	148.2	148.2	148.2
19	115.3	131.2	131.2	132.0	132.0	132.0	132.3	132.3	132.3	148.3	148.3	148.3	148.8	148.8	148.8
20	117.5	131.6	131.6	132.4	132.4	132.4	132.8	132.8	132.8	148.9	148.9	148.9	149.3	149.3	149.3
21	119.6	132.0	132.0	132.9	132.9	132.9	133.3	133.3	133.3	149.4	149.4	149.4	149.9	149.9	149.8
22	121.7	132.4	132.4	133.3	133.3	133.3	133.8	133.7	133.7	149.9	149.9	149.9	150.4	150.4	150.4
23	123.8	132.8	132.8	133.7	133.7	133.7	134.2	134.2	134.2	150.4	150.4	150.4	150.9	150.9	150.9
24	125.7	133.2	133.2	134.1	134.1	134.1	134.6	134.6	134.6	150.8	150.8	150.8	151.4	151.4	151.4
25	127.5	133.5	133.5	134.5	134.5	134.5	135.1	135.1	135.1	151.3	151.3	151.3	151.9	151.8	151.8
26	129.1	133.9	133.9	134.9	134.9	134.9	135.5	135.5	135.5	151.7	151.7	151.7	152.3	152.3	152.3
27	94.4	98.1	98.9	99.1	99.1	99.9	99.7	99.7	100.5	116.0	116.0	116.8	116.6	116.6	117.4
28	95.7	98.4	99.2	99.5	99.5	100.3	100.1	100.1	100.9	116.4	116.4	117.2	117.1	117.1	117.8
29	96.8	98.7	99.5	99.8	99.8	100.6	100.5	100.5	101.3	116.8	116.8	117.6	117.5	117.5	118.3
30	97.7	99.0	99.8	100.2	100.2	100.9	100.9	100.9	101.7	117.3	117.3	118.0	117.9	117.9	118.7
31	98.2	98.9	99.6	100.2	100.1	100.8	101.2	101.2	102.0	117.7	117.6	118.4	118.3	118.3	119.1
32	98.4	98.8	99.5	100.2	100.1	100.8	101.6	101.6	102.4	118.0	118.0	118.8	118.7	118.7	119.5
33	98.5	98.7	99.4	100.1	100.0	100.7	101.9	101.9	102.7	118.4	118.4	119.2	119.2	119.1	119.9
34	98.5	98.6	99.3	100.0	99.9	100.6	102.3	102.3	103.1	118.8	118.8	119.6	119.5	119.5	120.3
35	134.7	134.7	99.2	136.1	136.1	100.6	138.6	138.6	103.1	155.3	155.3	119.9	156.1	156.1	120.7
36	134.6	134.6	134.5	136.1	136.0	135.9	138.7	138.6	138.5	155.7	155.7	155.7	156.5	156.5	156.5
37	134.6	134.5	134.5	136.1	136.0	135.9	138.7	138.6	138.5	156.0	156.0	156.0	156.9	156.8	156.8
38	134.5	134.5	134.5	136.1	136.0	135.9	138.7	138.6	138.5	156.4	156.4	156.4	157.2	157.2	157.2
39	134.5	134.4	134.3	136.0	136.0	135.9	138.7	138.6	138.6	156.7	156.7	156.7	157.6	157.6	157.6
40	134.5	134.4	134.3	136.0	136.0	135.9	138.8	138.7	138.6	157.1	157.1	157.1	157.9	157.9	157.9
41	134.4	134.3	134.3	136.0	136.0	135.9	138.8	138.7	138.6	157.4	157.4	157.4	158.3	158.3	158.3
42	134.4	134.3	134.2	136.0	136.0	135.9	138.8	138.8	138.7	157.7	157.7	157.7	158.6	158.6	158.6
43	134.4	134.3	134.2	136.1	136.0	135.9	138.8	138.8	138.7	158.0	158.0	158.0	159.0	159.0	159.0
44	134.3	134.3	134.2	136.1	136.0	135.9	139.0	138.9	138.8	158.4	158.4	158.4	159.3	159.3	159.3
45	134.3	134.3	134.2	136.1	136.0	135.9	139.0	138.9	138.9	158.7	158.7	158.7	159.7	159.7	159.7
46	134.3	134.2	134.2	136.1	136.1	136.0	139.1	139.0	138.9	159.0	159.0	159.0	160.0	160.0	160.0
47	134.3	134.2	134.2	136.1	136.1	136.0	139.2	139.1	139.0	159.3	159.3	159.3	160.3	160.3	160.3
48	134.3	134.2	134.2	136.2	136.1	136.0	139.2	139.2	139.1	159.6	159.6	159.6	160.6	160.6	160.6
49	134.3	134.2	134.2	136.2	136.1	136.1	139.3	139.2	139.2	159.9	159.9	159.9	161.0	161.0	161.0
50	134.3	134.2	134.2	136.3	136.2	136.1	139.4	139.3	139.3	160.2	160.2	160.2	161.3	161.3	161.3
51	134.3	134.3	134.2	136.3	136.2	136.2	139.5	139.4	139.3	160.5	160.5	160.5	161.6	161.6	161.6
52	134.3	134.3	134.2	136.4	136.3	136.2	139.6	139.5	139.4	160.8	160.8	160.8	161.9	161.9	161.9
53	98.2	98.1	98.8	100.2	100.2	100.9	103.5	103.4	104.2	124.9	124.9	125.7	126.0	126.0	126.8
54	98.2	98.1	98.9	100.3	100.2	101.0	103.6	103.5	104.3	125.2	125.2	126.0	126.4	126.4	127.1

55	98.2	98.2	98.9	100.4	100.3	101.0	103.7	103.6	104.3	125.4	125.4	126.2	126.7	126.7	127.4
56	98.2	98.2	98.9	100.4	100.4	101.1	103.8	103.7	104.4	125.7	125.7	126.5	127.0	127.0	127.7
57	98.3	98.2	98.9	100.5	100.4	101.1	103.9	103.8	104.5	126.0	126.0	126.8	127.2	127.2	128.0
58	98.3	98.2	99.0	100.5	100.5	101.2	104.0	103.9	104.7	126.3	126.3	127.1	127.5	127.5	128.3
59	98.3	98.3	99.0	100.6	100.5	101.3	104.1	104.0	104.8	126.5	126.5	127.3	127.8	127.8	128.6
60	98.3	98.3	99.0	100.7	100.6	101.4	104.2	104.1	104.9	126.8	126.8	127.6	128.1	128.1	128.9
61	98.4	98.3	99.0	100.7	100.7	101.4	104.3	104.2	105.0	127.1	127.1	127.9	128.4	128.4	129.2
62	134.6	134.5	134.5	137.0	136.9	136.9	140.6	140.5	140.4	163.5	163.5	163.5	164.8	164.8	164.8
63	134.6	134.5	134.5	137.0	137.0	136.9	140.7	140.6	140.6	163.7	163.7	163.7	165.1	165.1	165.1
64	134.6	134.6	134.5	137.1	137.1	137.0	140.8	140.7	140.7	164.0	164.0	164.0	165.4	165.4	165.4
65	134.7	134.6	134.6	137.2	137.1	137.1	140.9	140.8	140.8	164.3	164.3	164.3	165.7	165.7	165.7
66	134.7	134.7	134.6	137.3	137.2	137.2	141.0	141.0	140.9	164.5	164.5	164.5	166.0	166.0	166.0
67	134.7	134.7	134.6	137.4	137.3	137.2	141.1	141.1	141.0	164.8	164.8	164.8	166.2	166.2	166.2
68	134.8	134.7	134.7	137.4	137.4	137.3	141.2	141.2	141.1	165.0	165.0	165.0	166.5	166.5	166.5
69	134.8	134.8	134.7	137.5	137.5	137.4	141.4	141.3	141.2	165.3	165.3	165.3	166.8	166.8	166.8
70	134.9	134.8	134.8	137.6	137.5	137.5	141.5	141.4	141.4	165.5	165.5	165.5	167.0	167.0	167.0
71	134.9	134.9	134.8	137.7	137.6	137.6	141.6	141.5	141.5	165.8	165.8	165.8	167.3	167.3	167.3
72	135.0	134.9	134.9	137.8	137.7	137.7	141.7	141.7	141.6	166.0	166.0	166.0	167.6	176.6	167.6
73	135.0	135.0	134.9	137.8	137.8	137.7	141.8	141.8	141.7	166.2	166.2	166.2	167.8	167.8	167.8
74	135.0	135.0	135.0	137.9	137.9	137.8	141.9	141.9	141.8	166.5	166.5	166.5	168.1	168.1	168.1
75	135.1	135.0	135.0	138.0	138.0	137.9	142.1	142.0	142.0	166.7	166.7	166.7	168.4	168.4	168.3
76	135.1	135.1	135.0	138.1	138.0	138.0	142.2	142.1	142.1	166.9	166.9	166.8	168.6	168.5	168.4
77	135.2	135.1	135.1	138.2	138.1	138.1	142.3	142.3	142.2	167.0	166.9	166.9	168.7	168.6	168.5
78	135.2	135.2	135.1	138.3	138.2	138.2	142.4	142.4	142.3	167.1	167.0	166.9	168.8	168.7	168.7
79	135.3	135.2	135.2	138.4	138.3	138.3	142.6	142.5	142.5	167.2	167.1	167.0	168.9	168.8	168.8
80	135.3	135.3	135.2	138.4	138.4	138.4	142.7	142.6	142.6	167.3	167.2	167.1	169.0	169.0	168.9
81	135.4	135.3	135.3	138.5	138.5	138.4	142.8	142.8	142.7	167.4	167.3	167.2	169.2	169.1	169.0
82	135.4	135.4	135.3	138.6	138.6	138.5	142.9	142.9	142.8	167.5	167.4	167.3	169.3	169.2	169.1
83	135.5	135.4	135.4	138.7	138.7	138.6	143.1	143.0	143.0	167.6	167.5	167.4	169.4	169.3	169.2
84	135.5	135.5	135.5	138.8	138.8	138.7	143.2	143.1	143.1	167.7	167.6	167.5	169.5	169.4	169.4
85	135.6	135.5	135.5	138.9	138.9	138.8	143.3	143.3	143.2	167.8	167.7	167.6	169.6	169.6	169.5
86	135.6	135.6	135.6	139.0	138.9	138.9	143.4	143.4	143.3	167.9	167.8	167.7	169.8	169.7	169.6
87	135.7	135.7	135.6	139.1	139.0	139.0	143.6	143.5	143.5	168.0	167.9	167.8	169.9	169.8	169.7
88	135.7	135.7	135.7	139.2	139.1	139.1	143.7	143.6	143.6	168.1	168.0	167.9	170.0	169.9	169.9
89	135.8	135.8	135.7	139.3	139.2	139.2	143.8	143.8	143.7	168.2	168.1	168.0	170.1	170.1	170.0
90	135.9	135.8	135.8	139.4	139.3	139.3	143.9	143.9	143.9	168.3	168.2	168.2	170.3	170.2	170.1
91	135.9	135.9	135.8	139.4	139.4	139.4	144.1	144.0	144.0	168.4	168.3	168.3	170.4	170.3	170.3
92	136.0	135.9	135.9	139.5	139.5	139.5	144.2	144.1	144.1	168.5	168.4	168.4	170.5	170.5	170.4
93	136.0	136.0	135.9	139.6	139.6	139.5	144.3	144.3	144.2	168.6	168.5	168.5	170.7	170.6	170.5
94	136.1	136.0	136.0	139.7	139.7	139.6	144.4	144.4	144.4	168.7	168.7	168.6	170.8	170.7	170.7
95	136.1	136.1	136.0	139.8	139.8	139.7	144.6	144.5	144.5	168.9	168.8	168.7	170.9	170.9	170.8
96	136.2	136.1	136.1	139.9	139.9	139.8	144.7	144.7	144.6	169.0	168.9	168.8	171.1	171.0	170.9
97	136.2	136.2	136.2	140.0	140.0	139.9	144.8	144.8	144.8	169.1	169.0	169.0	171.2	171.1	171.1
98	136.3	136.3	136.2	140.1	140.1	140.0	145.0	144.9	144.9	169.2	169.1	169.1	171.4	171.3	171.2
99	136.3	136.3	136.3	140.2	140.1	140.1	145.1	145.0	145.0	169.3	169.3	169.2	171.5	171.4	171.4
100	136.4	136.4	136.3	140.3	140.2	140.2	145.2	145.2	145.1	169.4	169.4	169.3	171.6	171.6	171.5
101	136.5	136.4	136.4	140.4	140.3	140.3	145.3	145.3	145.3	169.6	169.5	169.4	171.8	171.7	171.6
102	136.5	136.5	136.4	140.5	140.4	140.4	145.5	145.4	145.4	169.7	169.6	169.6	171.9	171.9	171.8
103	136.6	136.5	136.5	140.6	140.5	140.5	145.6	145.6	145.5	169.8	169.7	169.7	172.1	172.0	171.9
104	136.6	136.6	136.5	140.7	140.6	140.6	145.7	145.7	145.7	169.9	169.9	169.8	172.2	172.1	172.1
105	136.7	136.6	136.6	140.8	140.7	140.7	145.9	145.8	145.8	170.0	170.0	169.9	172.3	172.3	172.2
106	136.7	136.7	136.7	140.8	140.8	140.8	146.0	145.9	145.9	170.2	170.1	170.0	172.5	172.4	172.4
107	136.8	136.8	136.7	140.9	140.9	140.9	146.1	146.1	146.0	170.3	170.2	170.2	172.6	172.6	172.5
108	136.8	136.8	136.8	141.0	141.0	141.0	146.2	146.2	146.2	170.4	170.4	170.3	172.8	172.7	172.7
109	136.9	136.9	136.8	141.1	141.1	141.1	146.4	146.3	146.3	170.5	170.5	170.4	172.9	172.9	172.8
110	137.0	136.9	136.9	141.2	141.2	141.2	146.5	146.5	146.4	170.7	170.6	170.6	173.1	173.0	173.0
111	137.0	137.0	136.9	141.3	141.3	141.3	146.6	146.6	146.6	170.8	170.7	170.7	173.2	173.2	173.1
112	137.1	137.0	137.0	141.4	141.4	141.3	146.8	146.7	146.7	170.9	170.9	170.8	173.4	173.3	173.3
113	137.1	137.1	137.1	141.5	141.5	141.4	146.9	146.8	146.8	171.1	171.0	170.9	173.5	173.5	173.4
114	137.2	137.1	137.1	141.6	141.6	141.6	147.0	147.0	147.0	171.2	171.1	171.1	173.7	173.6	173.6
115	137.2	137.2	137.2	141.7	141.7	141.7	147.1	147.1	147.1	171.3	171.3	171.2	173.8	173.8	173.7
116	137.3	137.3	137.3	141.8	141.8	141.8	147.3	147.3	147.3	171.4	171.4	171.3	174.0	173.9	173.9
117	137.4	137.4	137.4	142.0	142.0	142.0	147.5	147.5	147.5	171.6	171.5	171.5	174.1	174.1	174.0
118	137.5	137.5	137.5	142.1	142.1	142.1	147.6	147.6	147.6	171.7	171.6	171.6	174.3	174.2	174.2
119	137.6	137.6	137.6	142.2	142.2	142.2	147.8	147.8	147.8	171.8	171.8	171.7	174.4	174.4	174.3
120	137.7	137.7	137.7	142.4	142.4	142.4	148.0	148.0	148.0	172.0	171.9	171.9	174.6	174.5	174.5

Mile	2000 Hz In	2000 Hz Cross	2000 Hz Deep	2500 Hz In	2500 Hz Cross	2500 Hz Deep	3500 Hz In	3500 Hz Cross	3500 Hz Deep	5000 Hz In	5000 Hz Cross	5000 Hz Deep	10000 Hz In	10000 Hz Cross	10000 Hz Deep
1	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3
2	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5
3	76.2	136.7	76.2	76.2	136.8	76.2	76.2	136.9	76.2	76.2	136.9	76.2	76.3	137.0	76.3
4	137.6	137.6	78.8	137.7	137.7	78.9	137.8	137.7	78.9	137.8	137.8	78.9	137.9	137.8	79.0
5	138.5	138.5	80.9	138.6	138.6	81.0	138.7	138.7	81.0	138.8	138.7	81.1	138.8	138.8	81.1
6	139.4	139.4	82.7	139.5	139.5	82.7	139.6	139.6	82.8	139.7	139.7	82.8	139.7	139.7	82.9
7	140.3	140.3	140.3	140.5	140.4	140.4	140.6	140.5	140.5	140.6	140.5	140.6	140.7	140.7	140.6
8	141.2	141.2	141.2	141.4	141.3	141.3	141.5	141.5	141.4	141.6	141.5	141.5	141.6	141.6	141.6
9	142.1	142.1	142.1	142.2	142.2	142.2	142.4	142.3	142.3	142.4	142.4	142.4	142.5	142.5	142.5
10	142.9	142.9	142.9	143.1	143.1	143.0	143.2	143.2	143.2	143.3	143.3	143.3	143.4	143.4	143.3
11	143.7	143.7	143.7	143.9	143.9	143.9	144.0	144.0	144.0	144.1	144.1	144.1	144.2	144.2	144.2
12	144.5	144.5	144.5	144.7	144.7	144.6	144.8	144.8	144.8	144.9	144.9	144.9	145.0	145.0	145.0
13	145.2	145.2	145.2	145.4	145.4	145.4	145.6	145.6	145.6	145.7	145.7	145.7	145.8	145.8	145.7
14	145.9	145.9	145.9	146.1	146.1	146.1	146.3	146.3	146.3	146.4	146.4	146.4	146.5	146.5	146.5
15	146.6	146.6	146.6	146.8	146.8	146.8	147.0	147.0	147.0	147.1	147.1	147.1	147.2	147.2	147.2
16	147.3	147.3	147.3	147.5	147.5	147.5	147.7	147.7	147.7	147.8	147.8	147.8	147.9	147.9	147.9
17	147.9	147.9	147.9	148.1	148.1	148.1	148.3	148.3	148.3	148.5	148.5	148.5	148.6	148.6	148.6
18	148.5	148.5	148.5	148.7	148.7	148.7	149.0	149.0	149.0	149.1	149.1	149.1	149.2	149.2	149.2
19	149.1	149.1	149.1	149.3	149.3	149.3	149.6	149.6	149.6	149.7	149.7	149.7	149.8	149.8	149.8
20	149.7	149.7	149.6	149.9	149.9	149.9	150.2	150.2	150.2	150.3	150.3	150.3	150.4	150.4	150.4
21	150.2	150.2	150.2	150.5	150.5	150.5	150.7	150.7	150.7	150.9	150.9	150.9	151.0	151.0	151.0
22	150.7	150.7	150.7	151.0	151.0	151.0	151.3	151.3	151.3	151.5	151.5	151.5	151.6	151.6	151.6
23	151.3	151.3	151.3	151.6	151.6	151.6	151.9	151.8	151.8	152.0	152.0	152.0	152.2	152.2	152.2
24	151.8	151.8	151.8	152.1	152.1	152.1	152.4	152.4	152.4	152.6	152.6	152.6	152.7	152.7	152.7
25	152.3	152.3	152.3	152.6	152.6	152.6	152.9	152.9	152.9	153.1	153.1	153.1	153.2	153.2	153.2
26	152.7	152.7	152.7	153.1	153.1	153.1	153.4	153.4	153.4	153.6	153.6	153.6	153.8	153.8	153.7
27	117.1	117.1	117.8	117.4	117.4	118.2	117.7	117.7	118.5	117.9	117.9	118.7	118.1	118.1	118.9
28	117.5	117.5	118.3	117.9	117.9	118.7	118.2	118.2	119.0	118.4	118.4	119.2	118.6	118.6	119.4
29	118.0	118.0	118.8	118.3	118.3	119.1	118.7	118.7	119.5	118.9	118.9	119.7	119.1	119.1	119.9
30	118.4	118.4	119.2	118.8	118.8	119.6	119.2	119.2	120.0	119.4	119.4	120.2	119.6	119.6	120.4
31	118.8	118.8	119.6	119.2	119.2	120.0	119.6	119.6	120.2	119.9	119.9	120.7	120.0	120.0	120.8
32	119.3	119.3	120.1	119.7	119.7	120.5	120.1	120.1	120.9	120.3	120.3	121.1	120.5	120.5	121.3
33	119.7	119.7	120.5	120.1	120.1	120.9	120.5	120.5	121.3	120.8	120.8	121.6	121.0	121.0	121.7
34	120.1	120.1	120.9	120.5	120.5	121.3	121.0	121.0	121.7	121.2	121.2	122.0	121.4	121.4	122.2
35	156.7	156.7	121.3	157.1	157.1	121.7	157.5	157.5	122.2	157.8	157.8	122.4	158.0	158.0	122.6
36	157.1	157.1	157.1	157.5	157.5	157.5	158.0	158.0	158.0	158.2	158.2	158.2	158.4	158.4	158.4
37	157.5	157.5	157.5	157.9	157.9	157.9	158.4	158.4	158.4	158.7	158.7	158.7	158.9	158.9	158.9
38	157.8	157.8	157.8	158.3	158.3	158.3	158.8	158.8	158.8	159.1	159.1	159.1	159.3	159.3	159.3
39	158.2	158.2	158.2	158.7	158.7	158.7	159.2	159.2	159.2	159.5	159.5	159.5	159.7	159.7	159.7
40	158.6	158.6	158.6	159.1	159.1	159.1	159.6	159.6	159.6	159.9	159.9	159.9	160.1	160.1	160.1
41	159.0	159.0	159.0	159.5	159.5	159.5	160.0	160.0	160.0	160.3	160.3	160.3	160.5	160.5	160.5
42	159.3	159.3	159.3	159.9	159.9	159.9	160.4	160.4	160.4	160.7	160.7	160.7	160.9	160.9	160.9
43	159.7	159.7	159.7	160.2	160.2	160.2	160.8	160.8	160.8	161.1	161.1	161.1	161.3	161.3	161.3
44	160.0	160.0	160.0	160.6	160.6	160.6	161.1	161.1	161.1	161.5	161.5	161.5	161.7	161.7	161.7
45	160.4	160.4	160.4	161.0	161.0	161.0	161.5	161.5	161.5	161.9	161.9	161.9	162.1	162.1	162.1
46	160.7	160.7	160.7	161.3	161.3	161.3	161.9	161.9	161.9	162.2	162.2	162.2	162.5	162.5	162.5
47	161.1	161.1	161.1	161.7	161.7	161.7	162.3	162.3	162.3	162.6	162.6	162.6	162.9	162.9	162.9
48	161.4	161.4	161.4	162.0	162.0	162.0	162.6	162.6	162.6	163.0	163.0	163.0	163.3	163.3	163.3
49	161.8	161.8	161.8	162.4	162.4	162.4	163.0	163.0	163.0	163.4	163.4	163.4	163.6	163.6	163.6
50	162.1	162.1	162.1	162.7	162.7	162.7	163.3	163.3	163.3	163.7	163.7	163.7	164.0	164.0	164.0
51	162.4	162.4	162.4	163.1	163.1	163.1	163.7	163.7	163.7	164.1	164.1	164.1	164.4	164.4	164.4

52	162.7	162.7	162.7	163.4	163.4	163.4	164.1	164.0	164.0	164.4	164.4	164.4	164.7	164.7	164.7
53	126.9	126.9	127.7	127.6	127.6	128.4	128.2	128.2	129.0	128.6	128.6	129.4	128.9	128.9	129.7
54	127.2	127.2	128.0	127.9	127.9	128.7	128.6	128.6	129.4	129.0	129.0	129.8	129.3	129.3	130.1
55	127.5	127.5	128.3	128.2	128.2	129.0	128.9	128.9	129.7	129.3	129.3	130.1	129.6	129.6	130.4
56	127.9	127.9	128.7	128.6	128.6	129.4	129.3	129.3	130.1	129.7	129.7	130.5	130.0	130.0	130.8
57	128.2	128.2	129.0	128.9	128.9	129.7	129.6	129.6	130.4	130.0	130.0	130.8	130.4	130.3	131.1
58	128.5	128.5	129.3	129.2	129.2	130.0	129.9	129.9	130.7	130.4	130.4	131.2	130.7	130.7	131.5
59	128.8	128.8	129.9	129.5	129.5	130.3	130.3	130.3	131.1	130.7	130.7	131.5	131.0	131.0	131.8
60	129.1	129.1	129.9	129.8	129.8	130.6	130.6	130.6	131.4	131.0	131.0	131.8	131.4	131.4	132.2
61	129.4	129.4	130.2	130.2	130.2	130.9	130.9	130.9	131.7	131.4	131.4	132.2	131.7	131.7	132.5
62	165.9	165.9	165.9	166.6	166.6	166.6	167.4	167.4	167.4	167.9	167.9	167.9	168.2	168.2	168.2
63	166.2	166.2	166.2	166.9	166.9	166.9	167.7	167.7	167.7	168.2	168.2	168.2	168.6	168.6	168.6
64	166.4	166.4	166.4	167.2	167.2	167.2	168.0	168.0	168.0	168.5	168.5	168.5	168.9	168.9	168.9
65	166.7	166.7	166.7	167.6	167.6	167.5	168.4	168.4	168.4	168.8	168.8	168.8	169.2	169.2	169.2
66	167.0	167.0	167.0	167.9	167.9	167.9	168.7	168.7	168.7	169.2	169.2	169.2	169.6	169.5	169.5
67	167.3	167.3	167.3	168.2	168.2	168.2	169.0	169.0	169.0	169.5	169.5	169.5	169.9	169.9	169.9
68	167.6	167.6	167.6	168.5	168.5	168.5	169.3	169.3	169.3	169.8	169.8	169.8	170.2	170.2	170.2
69	167.9	176.9	167.9	168.8	168.8	168.8	169.6	169.6	169.6	170.1	170.1	170.1	170.5	170.5	170.5
70	168.2	168.2	168.2	169.1	169.0	169.0	169.9	169.9	169.9	170.4	170.4	170.4	170.8	170.8	170.8
71	168.5	168.5	168.5	169.3	169.3	169.3	170.2	170.2	170.2	170.8	170.8	170.8	171.2	171.2	171.2
72	168.7	168.7	168.7	169.6	169.6	169.6	170.5	170.5	170.5	171.1	171.1	171.1	171.5	171.5	171.5
73	169.0	169.0	169.0	169.9	169.9	169.9	170.8	170.8	170.8	171.4	171.4	171.4	171.8	171.8	171.8
74	169.3	169.3	169.3	170.2	170.2	170.2	171.1	171.1	171.1	171.7	171.7	171.7	172.1	172.1	172.1
75	169.6	169.6	169.5	170.5	170.5	170.5	171.4	171.4	171.4	172.0	172.0	172.0	172.4	172.4	172.4
76	169.8	169.8	169.7	170.8	170.7	170.6	171.7	171.7	171.6	172.3	172.2	172.1	172.7	172.6	172.6
77	170.0	169.9	169.8	170.9	170.8	170.8	171.9	171.8	171.7	172.5	172.4	172.3	172.9	172.8	172.7
78	170.1	170.0	169.9	171.1	171.0	170.9	172.0	171.9	171.9	172.6	172.5	172.4	173.1	173.0	172.9
79	170.2	170.1	170.0	171.2	171.1	171.0	172.2	172.1	172.0	172.8	172.7	172.6	173.2	173.1	173.1
80	170.3	170.3	170.2	171.3	171.3	171.2	172.3	172.3	172.2	172.9	172.9	172.8	173.4	173.3	173.2
81	170.5	170.4	170.3	171.5	171.4	171.3	172.5	172.4	172.3	173.1	173.0	172.9	173.6	173.5	173.4
82	170.6	170.5	170.4	171.6	171.5	171.5	172.7	172.6	172.5	173.3	173.2	173.1	173.7	173.7	173.6
83	170.7	170.7	170.6	171.8	171.7	171.6	172.8	172.7	172.7	173.4	173.4	173.3	173.9	173.8	173.7
84	170.9	170.8	170.7	171.9	171.8	171.8	173.0	172.9	172.8	173.6	173.5	173.4	174.1	174.0	173.9
85	171.0	170.9	170.9	172.1	172.0	171.9	173.1	173.1	173.0	173.8	173.7	173.6	174.3	174.2	174.1
86	171.2	171.1	171.0	172.2	172.2	172.1	173.3	173.2	173.2	173.9	173.9	173.8	174.4	174.4	174.3
87	171.3	171.2	171.1	172.4	172.3	172.2	173.5	173.4	173.3	174.1	174.0	174.0	174.6	174.5	174.5
88	171.4	171.4	171.3	172.5	172.5	172.4	173.6	173.6	173.5	174.3	174.2	174.1	174.8	174.7	174.6
89	171.6	171.5	171.4	172.7	172.6	172.5	173.8	173.7	173.7	174.5	174.4	174.3	175.0	174.9	174.8
90	171.7	171.7	171.6	172.9	172.8	172.7	174.0	173.9	173.8	174.6	174.6	174.5	175.2	175.1	175.0
91	171.9	171.8	171.7	173.0	172.9	172.9	174.1	174.1	174.0	174.8	174.8	174.7	175.3	175.3	175.2
92	172.0	172.0	171.9	173.2	173.1	173.0	174.3	174.3	174.2	175.0	174.9	174.9	175.5	175.5	175.4
93	172.2	172.1	172.0	173.3	173.3	173.2	174.5	174.4	174.4	175.2	175.1	175.0	175.7	175.6	175.6
94	172.3	172.3	172.2	173.5	173.4	173.4	174.7	174.6	174.5	175.4	175.3	175.2	175.9	175.8	175.8
95	172.5	172.4	172.3	173.7	173.6	173.5	174.8	174.8	174.7	175.6	175.5	175.4	176.1	176.0	176.0
96	172.6	172.6	172.5	173.8	173.8	173.7	175.0	175.0	174.9	175.7	175.7	175.6	176.3	176.2	176.1
97	172.8	172.7	172.6	174.0	173.9	173.9	175.2	175.1	175.1	175.9	175.9	175.8	176.5	176.4	176.3
98	172.9	172.9	172.8	174.2	174.1	174.0	175.4	175.3	175.3	176.1	176.0	176.0	176.7	176.6	176.5
99	173.1	173.0	173.0	174.3	174.3	174.2	175.6	175.5	175.4	176.3	176.2	176.2	176.9	176.8	176.7
100	173.3	173.2	173.1	174.5	174.4	174.4	175.7	175.7	175.6	176.5	176.4	176.4	177.1	177.0	176.9
101	173.4	173.3	173.3	174.7	174.6	174.5	175.9	175.9	175.8	176.7	176.6	176.5	177.3	177.2	177.1
102	173.6	173.5	173.4	174.8	174.8	174.7	176.1	176.0	176.0	176.9	176.8	176.7	177.5	177.4	177.3
103	173.7	173.7	173.6	175.0	174.9	174.9	176.3	176.2	176.2	177.1	177.0	176.9	177.6	177.6	177.5
104	173.9	173.8	173.8	175.2	175.1	175.1	176.5	176.4	176.4	177.3	177.2	177.1	177.8	177.8	177.7
105	174.0	174.0	173.9	175.4	175.3	175.2	176.7	176.6	176.5	177.4	177.4	177.3	178.0	178.0	177.9
106	174.2	174.1	174.1	175.5	175.5	175.4	176.9	176.8	176.7	177.6	177.6	177.5	178.2	178.2	178.1
107	174.4	174.3	174.2	175.7	175.6	175.6	177.0	177.0	176.9	177.8	177.8	177.7	178.4	178.4	178.3
108	174.5	174.5	174.4	175.9	175.8	175.8	177.2	177.2	177.1	178.0	178.0	177.9	178.6	178.6	178.5
109	174.7	174.6	174.6	176.1	176.0	175.9	177.4	177.4	177.3	178.2	178.2	178.1	178.8	178.8	178.7
110	174.9	174.8	174.7	176.2	176.2	176.1	177.6	177.5	177.5	178.4	178.4	178.3	179.0	179.0	178.9
111	175.0	175.0	174.9	176.4	176.3	176.3	177.8	177.7	177.7	178.6	178.6	178.5	179.3	179.2	179.1
112	175.2	175.1	175.1	176.6	176.5	176.5	178.0	177.9	177.9	178.8	178.8	178.7	179.5	179.4	179.3
113	175.4	175.3	175.2	176.8	176.7	176.6	178.2	178.1	178.1	179.0	179.0	178.9	179.7	179.6	179.5
114	175.5	175.5	175.4	176.9	176.9	176.8	178.4	178.3	178.3	179.2	179.2	179.1	179.9	179.8	179.7
115	175.7	175.6	175.6	177.1	177.1	177.0	178.6	178.5	178.4	179.4	179.4	179.3	180.1	180.0	180.0
116	175.9	175.8	175.7	177.3	177.2	177.2	178.8	178.7	178.6	179.6	179.6	179.5	180.3	180.2	180.2
117	176.0	176.0	175.9	177.5	177.4	177.4	178.9	178.9	178.8	179.8	179.8	179.7	180.5	180.4	180.4
118	176.2	176.1	176.1	177.7	177.6	177.6	179.1	179.1	179.0	180.0	180.0	179.9	180.7	180.6	180.6
119	176.4	176.3	176.3	177.8	177.8	177.7	179.3	179.3	179.2	180.2	180.2	180.1	180.9	180.8	180.8
120	176.5	176.5	176.4	178.0	178.0	177.9	179.5	179.5	179.4	180.4	180.4	180.3	181.1	181.0	181.0

TABLE A-2

ENVIRONMENT FILE = A123D.ENV

SONIC LAYER DEPTH = 314 feet

NUMBER OF FREQUENCIES = 20

NUMBER OF ACTIVE SONOBUOYS = 3

NUMBER OF ACTIVE SONARS = 24

FREQUENCIES (Hz):
10	15	20	30	40	60	80	100	125	250	315	630	900	1250	1600	2000	2500	3500	5000	10000

AMBIENT NOISE (dB):
76	80	82	87	89	91	89	87	85	84	85	86	87	87	87	87	87	86	84	79

ACTIVE SONOBUOY DATA:

Type	Range (nautical miles)
SSQ47	2.00
SSQ50	3.00
SSQ62	3.00

ACTIVE SONAR DATA. (depth in feet, ranges in nautical miles)

	Dip/Tow	12 knots		18 knots		24 knots		BB Range Limits				CZ Limits	
Type	Depth	In	Deep	In	Deep	In	Deep	Inner	Outer	Inner	Outer	Inner	Outer
AQS13	50	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARTIM	0	3.0	2.0	3.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
BGQ5A	0	19.0	3.0	15.0	3.0	11.0	3.0	11.0	14.0	11.0	14.0	0.0	0.0
BULLN	0	4.0	2.0	3.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
BWOOD	0	2.0	0.0	2.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FENKM	0	2.0	2.0	2.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOALT	0	2.0	2.0	2.0	2.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
MARET	0	3.0	2.0	2.0	2.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
NEWCN	0	7.0	2.0	4.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
OQS01	0	11.0	3.0	8.0	3.0	3.0	2.0	10.0	12.0	10.0	12.0	0.0	0.0
OQS3	0	8.0	3.0	4.0	3.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
OQS4	0	9.0	0.0	5.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PEGA2	0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHRKF	0	2.0	2.0	2.0	2.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
SHRKT	0	3.0	2.0	3.0	2.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
SGQ23	0	9.0	2.0	7.0	2.0	4.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
SGR26	0	12.0	3.0	12.0	3.0	10.0	3.0	24.0	30.0	24.0	30.0	0.0	0.0
SQS23	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SQS26	0	11.0	3.0	9.0	3.0	4.0	2.0	15.0	19.0	15.0	19.0	0.0	0.0
SQS35	250	3.0	1.0	3.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SQS53	0	12.0	3.0	12.0	3.0	12.0	3.0	22.0	28.0	22.0	28.0	0.0	0.0
SQS56	0	5.0	2.0	4.0	2.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
TAMRS	0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TMR11	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PROPAGATION LOSS DATA: (all values in dB)

	10 Hz			15 Hz			20 Hz			30 Hz			40 Hz		
Mile	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep
1	80.1	78.0	64.9	74.9	75.5	64.9	72.5	74.5	64.9	74.2	75.2	64.9	93.2	76.5	64.9
2	81.2	79.0	71.7	75.8	76.4	71.7	73.2	75.4	71.7	73.8	76.5	71.8	84.4	82.8	71.8
3	82.8	80.1	73.9	77.2	77.4	74.0	74.3	76.2	74.0	73.6	76.6	74.0	80.0	81.6	74.1
4	84.8	81.4	75.9	79.0	78.6	76.0	75.7	77.2	76.0	73.9	76.9	76.0	77.4	79.8	76.1
5	86.8	82.8	77.8	80.8	79.9	77.9	77.4	78.3	77.9	74.8	77.5	78.0	76.3	79.1	78.0
6	88.7	84.2	79.6	82.7	81.3	79.7	79.1	79.5	79.7	75.9	78.3	79.8	76.2	79.1	79.9
7	90.5	85.6	81.4	84.5	82.6	81.5	80.8	80.8	81.5	77.2	79.2	81.7	76.6	79.5	81.8
8	90.5	85.0	80.2	84.3	81.9	80.3	80.4	80.0	80.4	76.2	78.1	80.6	74.8	77.9	80.8
9	91.9	85.3	79.5	85.7	82.2	79.7	81.7	80.2	79.8	77.2	78.1	80.0	75.3	77.5	80.2
10	93.5	86.4	79.9	87.2	83.2	80.0	83.2	81.2	80.1	78.6	78.9	80.3	76.3	78.0	80.5
11	95.1	87.4	80.3	88.7	84.3	80.4	84.7	82.2	80.5	79.9	79.8	80.6	77.5	78.6	80.8
12	96.5	88.5	80.6	90.2	85.3	80.7	86.1	83.2	80.8	81.2	80.6	80.9	78.7	79.3	81.1
13	97.9	89.5	80.9	91.5	86.3	81.0	87.4	84.1	81.0	82.5	81.5	81.2	79.9	80.0	81.3
14	99.2	90.5	81.1	92.8	87.2	81.2	88.7	85.1	81.3	83.8	82.3	81.4	81.1	80.8	81.6
15	100.6	91.6	81.4	94.3	88.3	81.5	90.1	86.1	81.5	85.2	83.3	81.7	82.4	81.7	81.8
16	98.9	90.6	81.0	92.5	87.4	81.1	88.4	85.3	81.1	83.5	82.7	81.3	81.2	81.4	81.5
17	98.1	89.9	80.6	91.7	86.8	80.7	87.6	84.7	80.8	82.7	82.3	81.0	80.5	81.1	81.2
18	99.5	90.8	80.9	93.1	87.6	81.0	88.8	85.6	81.1	83.8	83.0	81.3	81.4	81.8	81.4
19	100.5	91.5	81.1	94.1	88.3	81.2	89.8	86.2	81.3	84.7	83.7	81.5	82.1	82.3	81.7
20	101.5	92.2	81.4	95.0	89.0	81.5	90.7	86.9	81.6	85.5	84.3	81.7	82.8	82.9	81.9
21	102.5	92.9	81.7	96.0	89.7	81.8	91.7	87.6	81.8	86.3	84.9	82.0	83.4	83.5	82.1
22	103.5	93.6	82.0	97.0	90.4	82.1	92.6	88.2	82.1	87.1	85.5	82.3	84.1	84.0	82.4
23	104.5	94.3	82.3	97.9	91.1	82.4	93.5	88.9	82.5	87.9	86.1	82.6	84.8	84.6	82.7
24	101.6	92.7	82.1	95.2	89.6	82.2	91.0	87.6	82.3	86.0	85.1	82.5	83.4	83.9	82.7
25	101.2	92.5	82.2	94.9	89.4	82.3	90.7	87.4	82.4	85.7	85.0	82.7	83.2	83.9	82.9
26	102.3	93.2	82.6	95.9	90.1	82.7	91.7	88.0	82.9	86.5	85.6	83.1	83.9	84.4	83.3
27	103.1	93.7	83.0	96.6	90.6	83.1	92.4	88.5	83.2	87.1	86.0	83.4	84.4	84.8	83.7
28	103.8	94.2	83.4	97.4	91.0	83.5	93.1	89.0	83.6	87.7	86.4	83.8	84.9	85.1	84.1
29	104.6	94.7	83.8	98.1	91.5	83.9	93.7	89.4	84.0	88.4	86.8	84.3	85.4	85.5	84.5
30	105.3	95.1	84.2	98.8	91.9	84.3	94.4	89.8	84.4	89.0	87.2	84.7	85.9	85.8	84.9
31	104.8	95.0	84.4	98.4	91.8	84.5	94.1	89.8	84.6	88.8	87.2	84.9	85.9	85.9	85.1
32	103.5	94.3	84.3	97.2	91.3	84.5	93.0	89.3	84.6	88.0	86.9	84.9	85.4	85.7	85.2
33	103.3	94.3	84.4	97.0	91.2	84.6	92.9	89.2	84.8	87.9	86.9	85.1	85.4	85.8	85.4
34	104.0	94.7	84.7	97.7	91.6	84.9	93.5	89.6	85.0	88.5	87.3	85.4	85.9	86.1	85.7
35	104.6	95.1	85.0	98.3	92.0	85.1	94.1	90.0	85.3	89.0	87.6	85.6	86.3	86.4	85.9
36	105.2	95.5	85.2	98.8	92.4	85.4	94.6	90.3	85.6	89.4	87.9	85.9	86.7	86.6	86.2
37	105.8	95.8	85.4	99.4	92.7	85.6	95.1	90.7	85.8	89.9	88.2	86.1	87.1	86.9	86.4
38	106.4	96.2	85.6	99.9	93.1	85.8	95.7	91.0	86.0	90.3	88.5	86.3	87.4	87.2	86.6
39	106.9	96.6	85.8	100.5	93.4	86.0	96.2	91.4	86.2	90.8	88.8	86.5	87.8	87.5	86.8
40	107.5	96.9	86.0	101.0	93.8	86.1	96.7	91.7	86.3	91.3	89.2	86.6	88.2	87.7	86.9
41	108.0	97.3	86.1	101.6	94.1	86.3	97.2	92.0	86.4	91.7	89.5	86.7	88.6	88.0	87.0
42	108.6	97.6	86.3	102.1	94.5	86.4	97.7	92.4	86.6	92.2	89.8	86.9	89.0	88.3	87.2
43	105.8	96.1	85.8	99.5	93.1	86.0	95.3	91.2	86.2	90.4	88.9	86.6	87.8	87.7	87.0
44	106.2	96.5	86.0	99.9	93.4	86.2	95.8	91.5	86.4	90.7	89.1	86.7	88.1	87.9	87.1
45	106.7	96.8	86.1	100.4	93.7	86.3	96.2	91.7	86.5	91.1	89.4	86.9	88.4	88.1	87.2
46	107.2	97.1	86.2	100.8	94.0	86.4	96.6	92.0	86.6	91.5	89.6	87.0	88.7	88.4	87.3
47	107.6	97.3	86.3	101.3	94.3	86.5	97.0	92.3	86.7	91.9	89.9	87.1	89.0	88.6	87.4
48	108.1	97.6	86.5	101.7	94.6	86.6	97.5	92.6	86.8	92.2	90.1	87.2	89.3	88.8	87.5
49	108.5	97.9	86.6	102.1	94.9	86.8	97.9	92.8	86.9	92.6	90.4	87.3	89.7	89.0	87.6
50	109.0	98.2	86.7	102.6	95.1	86.9	98.3	93.1	87.1	93.0	90.6	87.4	90.0	89.2	87.7
51	109.4	98.5	86.8	103.0	95.4	87.0	98.7	93.4	87.2	93.3	90.9	87.5	90.3	89.5	87.8
52	107.1	97.3	86.5	100.9	94.3	86.7	96.8	92.4	87.0	91.9	90.2	87.4	87.4	89.0	87.7
53	107.5	97.6	86.7	101.3	94.6	86.9	97.2	92.7	87.1	92.2	90.4	87.5	89.6	89.2	87.8
54	107.9	97.8	86.8	101.6	94.8	87.0	97.5	92.9	87.2	92.5	90.6	87.6	89.9	89.4	88.0
55	108.3	98.1	86.9	102.0	95.1	87.1	97.9	93.1	87.3	92.8	90.8	87.7	90.1	89.6	88.1
56	108.7	98.3	87.0	102.4	95.3	87.3	98.2	93.4	87.5	93.1	91.0	87.9	90.4	89.8	88.2
57	109.0	98.6	87.2	102.7	95.5	87.4	98.6	93.6	87.6	93.4	91.2	88.0	90.7	90.0	88.3
58	109.4	98.8	87.3	103.1	95.8	87.5	98.9	93.8	87.7	93.8	91.4	88.1	90.5	90.1	88.5
59	109.8	99.0	87.5	103.5	96.0	87.7	99.3	94.0	87.9	94.1	91.5	88.2	91.2	90.3	88.6
60	107.8	98.1	87.3	101.7	95.1	87.6	97.7	93.3	87.8	92.9	91.1	88.2	90.5	90.0	88.6
61	106.2	98.3	87.4	102.1	95.4	87.6	98.0	93.5	87.8	93.2	91.3	88.3	90.7	90.2	88.7

106

62	108.5	98.5	87.5	102.4	95.6	87.7	98.3	93.7	88.0	93.5	91.5	88.4	90.9	90.4	88.8
63	108.9	98.7	87.6	102.7	95.8	87.9	98.6	93.9	88.1	93.7	91.7	68.6	91.2	90.5	89.0
64	109.2	98.9	87.8	103.0	96.0	88.0	98.9	94.1	88.2	94.0	91.8	88.7	91.4	90.7	89.1
65	109.5	99.1	87.9	103.3	96.2	88.1	99.2	94.3	88.4	94.3	92.0	88.8	91.6	90.8	89.2
66	109.9	99.3	88.0	103.6	96.4	88.3	99.5	94.5	88.5	94.5	92.2	89.0	91.8	91.0	89.4
67	110.2	99.6	88.2	104.0	96.6	88.4	99.8	94.7	88.6	94.8	92.4	89.1	92.1	91.2	89.5
68	110.5	99.8	88.3	104.3	96.8	88.5	100.1	94.9	88.8	95.1	92.6	89.2	92.3	91.3	89.6
69	108.9	98.9	88.1	102.8	96.1	88.4	98.8	94.2	88.6	94.1	92.2	89.2	91.7	91.1	89.6
70	109.2	99.1	88.2	103.1	96.2	88.5	99.1	94.4	88.8	94.4	92.3	89.3	91.9	91.3	89.7
71	109.5	99.3	88.3	103.4	96.4	88.6	99.4	94.6	88.9	94.6	92.5	89.4	92.1	91.4	89.8
72	109.8	99.5	88.4	103.6	96.6	88.7	99.6	94.8	89.0	94.8	92.6	89.5	92.3	91.5	89.9
73	110.0	99.7	88.5	103.9	96.8	88.8	99.9	94.9	89.1	95.1	92.8	89.6	92.5	91.7	90.0
74	110.3	99.9	88.6	104.2	97.0	88.9	100.2	95.1	89.2	95.3	92.9	89.7	92.7	91.8	90.1
75	110.6	100.1	88.7	104.5	97.1	89.0	100.4	95.3	89.3	95.5	93.1	89.8	92.9	92.0	90.2
76	110.9	100.2	88.8	104.7	97.3	89.1	100.7	95.5	89.4	95.8	93.3	89.9	93.1	92.1	90.3
77	109.5	99.9	88.8	103.5	97.1	89.1	99.6	95.3	89.4	95.0	93.2	89.9	92.7	92.1	90.4
78	109.7	99.7	88.7	103.7	96.9	89.1	99.8	95.1	89.3	95.2	93.1	89.9	92.9	92.1	90.4
79	110.0	99.9	88.8	104.0	97.0	89.1	100.1	95.3	89.4	95.4	93.2	90.0	93.0	92.2	90.5
80	110.3	100.0	88.9	104.2	97.2	89.2	100.3	95.4	89.5	95.6	93.4	90.1	93.2	92.3	90.5
81	110.5	100.2	89.0	104.5	97.4	89.3	100.5	95.6	89.6	95.8	93.5	90.1	93.4	92.4	90.6
82	110.8	100.4	89.1	104.7	97.5	89.4	100.8	95.7	89.7	96.0	93.6	90.2	93.6	92.6	90.7
83	111.0	100.5	89.2	105.0	97.7	89.5	101.0	95.9	89.7	96.2	93.8	90.3	93.7	92.7	90.8
84	111.3	100.7	89.2	105.2	97.8	89.5	101.2	96.0	89.8	96.4	93.9	90.4	93.9	92.8	90.8
85	111.6	100.8	89.3	105.4	98.0	89.6	101.5	96.2	89.9	96.6	94.0	90.4	94.1	92.9	90.9
86	110.3	100.2	89.1	104.3	97.5	89.5	100.5	95.7	89.8	96.0	93.8	90.4	93.7	92.8	90.9
87	110.5	100.4	89.2	104.6	97.6	89.6	100.7	95.9	89.9	96.2	93.9	90.5	93.9	92.9	91.0
88	110.8	100.5	89.3	104.8	97.7	89.6	100.9	96.0	89.9	96.4	94.0	90.5	94.1	93.0	91.0
89	111.0	100.7	89.4	105.0	97.9	89.7	101.2	96.1	90.0	96.6	94.1	90.6	94.2	93.1	91.1
90	111.2	100.8	89.5	105.2	98.0	89.8	101.4	96.3	90.1	96.8	94.3	90.7	94.4	93.3	91.2
91	111.5	101.0	89.5	105.5	98.2	89.9	101.6	96.4	90.2	96.9	94.4	90.7	94.5	93.4	91.2
92	111.7	101.1	89.6	105.7	98.3	89.9	101.8	96.5	90.2	97.1	94.5	90.8	94.7	93.5	91.3
93	111.9	101.3	89.7	105.9	98.4	90.0	102.0	96.7	90.3	97.3	94.6	90.9	94.8	93.6	91.4
94	112.1	101.0	89.7	106.1	98.3	90.0	102.2	96.6	90.3	97.5	94.6	90.9	95.0	93.6	91.4
95	111.0	100.8	89.6	105.1	98.1	90.0	101.4	96.4	90.3	97.0	94.5	90.9	94.7	93.6	91.5
96	111.2	101.0	89.7	105.3	98.3	90.1	101.6	96.6	90.4	97.1	94.7	91.0	94.9	93.7	91.6
97	111.4	101.1	89.8	105.5	98.4	90.2	101.7	96.7	90.5	97.3	94.8	91.1	95.0	93.8	91.6
98	111.6	101.2	89.9	105.7	98.5	90.2	101.9	96.8	90.6	97.5	94.9	91.2	95.2	93.9	91.7
99	111.9	101.4	90.0	105.9	98.6	90.3	102.1	96.9	90.6	97.6	95.0	91.3	95.3	94.0	91.8
100	112.1	101.5	90.0	106.1	98.8	90.4	102.3	97.1	90.7	97.8	95.1	91.3	95.4	94.1	91.9
101	112.3	101.7	90.1	106.3	98.9	90.5	102.5	97.2	90.8	97.9	95.2	91.4	95.6	94.2	91.9
102	112.5	101.8	90.2	106.5	99.0	90.5	102.7	97.3	90.9	98.1	95.3	91.5	95.7	94.3	92.0
103	111.5	101.3	90.1	105.7	98.6	90.5	102.0	97.0	90.8	97.7	95.2	91.5	95.5	94.3	92.1
104	111.7	101.4	90.2	105.9	98.8	90.6	102.1	97.1	90.9	97.8	95.3	91.6	95.6	94.4	92.1
105	111.9	101.5	90.2	106.0	98.9	90.6	102.3	97.2	91.0	98.0	95.4	91.7	95.8	94.5	92.2
106	112.1	101.7	90.3	106.2	99.0	90.7	102.5	97.3	91.1	98.1	95.5	91.7	95.9	94.6	92.3
107	112.2	101.8	90.4	106.4	99.1	90.8	102.7	97.5	91.1	98.3	95.6	91.8	96.0	94.7	92.4
108	112.4	101.9	90.5	106.6	99.2	90.8	102.8	97.6	91.2	98.4	95.7	91.9	96.2	94.8	92.4
109	112.6	102.0	90.5	106.8	99.3	90.9	103.0	97.7	91.3	98.6	95.8	91.9	96.3	94.9	92.5
110	112.8	102.2	90.6	106.9	99.5	91.0	103.2	97.8	91.3	98.7	95.9	92.0	96.4	94.9	92.6
111	113.0	102.3	90.6	107.1	99.6	91.0	103.3	97.9	91.4	98.9	96.0	92.1	96.5	95.0	92.6
112	112.1	101.8	90.6	106.4	99.2	91.0	102.7	97.6	91.4	98.5	95.9	92.2	96.4	95.0	92.7
113	112.3	102.0	90.6	106.5	99.3	91.1	102.9	97.7	91.4	98.6	96.0	92.1	96.5	95.1	92.7
114	112.5	102.1	90.7	106.7	99.4	91.1	103.0	97.8	91.5	98.8	96.1	92.2	96.6	95.2	92.8
115	112.6	102.2	90.8	106.9	99.6	91.2	103.2	97.9	91.6	98.9	96.1	92.2	96.7	95.3	92.8
116	112.8	102.3	90.8	107.0	99.7	91.2	103.3	98.0	91.6	99.0	96.2	92.3	96.9	95.4	92.9
117	113.0	102.4	90.9	107.2	99.8	91.3	103.5	98.1	91.7	99.2	96.3	92.4	97.0	95.4	92.9
118	113.2	102.5	90.9	107.4	99.9	91.3	103.7	98.2	91.7	99.3	96.4	92.4	97.1	95.5	93.0
119	113.3	102.6	91.0	107.5	100.0	91.4	103.8	98.3	91.8	99.5	96.5	92.5	97.2	95.6	93.1
120	112.5	102.2	90.9	106.8	99.7	91.4	103.3	98.1	91.8	99.2	95.4	92.5	97.1	95.6	93.1

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Mile	60 Hz In	Cross	Deep	80 Hz In	Cross	Deep	100 Hz In	Cross	Deep	125 Hz In	Cross	Deep	250 Hz In	Cross	Deep
1	74 2	66.8	64.9	71.5	64.1	64.9	70 5	63 3	64.8	69 5	63 1	64 8	68.1	62.7	64 8
2	81 2	73.7	71.8	75.9	71.7	71.8	75.7	70 7	71.8	74 3	70.3	71 8	72.1	69 3	71 8
3	86.5	79 5	74 1	77.5	78.6	74.2	78.2	78.3	74.2	77 3	77 3	74 2	74 7	74 7	74 4
4	87 9	82.2	76 2	79 5	79.5	76 3	79 5	79 9	76.3	79.2	79 2	76 4	76 8	76.8	76.7
5	87 2	84 0	78.2	82.1	80.6	78.3	80.7	80.9	78.4	80.7	80 7	78.5	78.6	78.6	78 9
6	84.7	83.9	80.1	83.8	81.9	80.3	81.9	81.8	80.4	81.8	81 8	80.6	80.2	80.2	81.3
7	82.3	83.2	82.0	84.3	83.0	82.2	82.9	82.6	82.5	82.7	82.7	82 7	81 5	81 5	83.8
8	78.3	80 8	81.2	82.3	82.1	81.6	81.9	81.8	82.0	81.9	82 3	82 5	82.6	82 6	84 7
9	77.1	79.5	80.6	81.3	81.5	81.1	81.8	81 4	81.5	82.0	82 0	82.1	83.2	83.2	84.7
10	76.8	79 3	80.9	80.7	81.4	81.3	81.9	81.6	81 7	82.3	82.1	82.2	83.7	83.6	84 6
11	77 0	79 3	81.2	80.3	81.3	81 6	82.0	81 8	81.9	82.5	82 3	82 4	84 0	83 8	84.6
12	77.4	79 4	81.4	90.1	81 2	81.8	82.1	82.0	82.1	82.7	82.4	82 5	84.3	84 0	84.5
13	78.1	79.7	81.6	80.1	81.2	81 9	82.1	82.1	82.2	82.8	82. 5	82 6	84 4	84 0	84.5
14	78.9	80 1	81.8	80.2	81.3	82.1	82.3	82.2	82.4	83 0	82.5	82 7	84 5	84 0	84.4
15	79.8	80.5	82.0	80 6	81.4	82 3	82 4	82.3	82.5	83.2	82 6	82 8	84.6	84 0	84 4
16	80.1	80.6	81.8	80 8	81.3	82 1	82.3	82.1	82.4	83 0	82 4	82.7	84 6	83.9	84 3
17	80.2	80.7	81.6	81.0	81.3	81.9	82.2	81.9	82.2	82.9	82 3	82 6	84 6	83 8	84 2
18	80.9	81.1	81.8	81.5	81.4	82.1	82 4	81 9	82 4	83 0	82 3	82 7	84 6	83 7	84 2
19	81.4	81.4	82.0	81 9	81.6	82.3	82.6	81.9	82.5	83 1	82 3	82 9	84 6	83 6	84.3
20	81.8	81.7	82.2	82.3	81.7	82.4	82.8	82 0	82.7	83.2	82 3	83 0	84 6	83.5	84 3
21	82.2	82.0	82 4	82.6	81.8	82.7	82.9	82.0	82.9	83.3	82 2	83 2	84 6	83.4	84 4
22	82.6	82.3	82.7	83 0	81.9	82.9	83.1	82.0	83 2	83 4	82.2	83 4	84 6	83 3	84 6
23	83.0	82.6	83.0	83.2	82.0	83 2	83.2	82.0	83.5	83.5	82 2	83.7	84 7	83.3	84.9
24	82.8	82.6	83.0	83.3	82.0	83.3	83.2	81.9	83.6	83.5	82.2	84 0	84 7	83 2	85.2
25	82.9	82.0	83.3	83.5	82.1	83.6	83.3	82.0	83.9	83.5	82 2	84 3	84 7	83 2	85 6
26	83.2	82.9	83 7	83.7	82 2	84.0	83 5	82.1	84 3	83.7	82.4	84 7	84 8	83 3	86.0
27	83 5	83.1	84 0	83.9	82.4	84 4	83.7	82.3	84.7	83 8	82.5	85 1	84 9	83 5	86.4
28	83 7	83.4	84 5	84 2	82.7	84 8	83.9	82 5	85.1	84 0	82 8	85 5	85 1	83 8	87 0
29	84.0	83 7	84 9	84 4	83.0	85.3	84.1	82 9	85.6	84 2	83 1	86 0	85 3	84 1	87.5
30	84 3	84 0	85.3	84 6	83.4	85 7	84 4	83 3	86 1	84.5	83.5	86 5	85 6	84 6	88 1
31	84.5	84 3	85 6	84 9	83.8	86.0	84.7	83.7	86.4	84 9	84 0	86.9	86 0	85 1	68 6
32	84 6	84 5	85.7	85.1	84.2	86 2	85 1	84 3	86.6	85 3	84 6	87 1	86.5	85 8	89 0
33	84 7	84 8	86 0	85 4	84.7	86.5	85.5	84 9	86 9	85 8	85 2	87 4	87 1	86 6	89 4
34	85 0	85 2	86 2	85 8	85.3	86.8	86 1	85.6	87 2	86.4	86.0	87 8	87 9	87 5	89 8
35	85.3	85 5	86.5	86 2	85.8	87 1	86.7	86 2	87 5	87 2	86 5	88 1	88.8	88 4	90.2
36	85.5	85 8	86.8	86.6	86.1	87 3	87 5	86 5	87 8	88 1	87 0	88 4	90 1	88.8	90 7
37	85.8	86.0	87 0	87 0	86.4	87 5	88 4	86 9	88.0	89 2	87 4	88 6	91 8	89 3	90.9
38	86.0	86 2	87 2	87.3	86.7	87 7	88.8	87 2	88.2	89 7	87 7	88 8	92 6	89 8	91.1
39	86.3	86.5	87 4	87 4	87.0	87 9	88 8	87 6	88 4	89 7	88 1	89 0	92.5	90 3	91.4
40	86.5	86.7	87.5	87 5	87.3	88.0	88 8	87 9	88 5	89.6	88 5	89 1	92 4	90.8	91 4
41	86.7	86.9	87.6	87.6	87 4	88.1	88 8	88 1	88.6	89 6	88 6	89 1	92 3	91.0	91.5
42	87 0	87 0	87 7	87.8	87 4	88.2	88.8	88.0	88.7	89 6	88 6	89 2	92.2	90 9	91.5
43	86.7	86.9	87 6	87 9	87 4	88.2	88 9	87.7	88.7	89 5	88 4	89 3	92 1	90 7	91.6
44	86.9	87 0	87 7	88.0	87 4	88 3	88 9	87 9	88.8	89 5	88 4	89 4	92.0	90 6	91.7
45	87 0	87 1	87.8	88.1	87 4	88 4	88.9	87.9	88.9	89 5	88 3	89 5	92.0	90 5	91.8
46	87 2	87 2	87 9	88.2	87.4	88 5	88.9	87.9	89 0	89 5	88.3	89 5	91.9	90 3	91.8
47	87 4	87 3	88 0	88 2	87 4	88.5	89 0	87.8	89.0	89 5	88 2	89 6	91.8	90 2	91.8
48	87 6	87 4	88 1	88 3	87.4	88 6	89 0	87 8	89 1	89 6	88 2	89 6	91.8	90 1	91 8
49	87 7	87 5	88 2	88 4	87 5	88.7	89 0	87 8	89 2	89 6	88 2	89 7	91.7	90 1	91.9
50	87 9	87 6	88 3	88.5	87 5	88 8	89 1	87 8	89.3	89 6	88 2	89 8	91.6	90 0	92.0
51	88 1	87 7	88 4	88 6	87 5	88 9	89 1	87.8	89 4	89 6	88.2	89 9	91.6	90 0	92.1
52	87 9	87 6	88 4	88 6	87 5	88 9	89 2	87 8	89.4	89 6	88 2	90 0	91.5	90 0	92.2
53	88.0	87 7	88 5	88 7	87 5	89 1	89 2	87 9	89 6	89 5	88 2	90 1	91.5	89 9	92 3
54	88.2	87 8	88 6	88 8	87 6	89 2	89 2	87 7	89 7	89 5	88 2	90 2	91.5	89 7	92 4
55	88 3	87 9	88 7	88 8	87 6	89 3	89 3	87 9	89 8	89 7	88 3	90 4	91.5	90 0	92 5
56	88 5	88 0	88 9	88 9	87 7	89 4	89 4	88 0	89 9	89 7	88 3	90 5	91 5	90 0	92 7
57	88 4	88 1	89 0	88 9	87 8	89 5	89 4	88 1	90 1	89 8	88 4	90 6	91 5	90 1	92 8
58	88 7	88 2	89 1	89 0	87 8	89 7	89 5	88 1	90 2	89 9	88 5	90 7	91 6	90 2	93 0

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TABLE A-2
(Continued)

59	88.9	88.3	89.2	89.1	87.9	89.8	89.5	88.2	90.3	90.0	88.6	90.9	91.6	90.3	93.1
60	88.8	88.3	89.3	89.1	88.0	89.9	89.6	88.3	90.4	90.0	88.7	91.0	91.7	90.4	93.3
61	89.0	88.5	89.4	89.2	88.1	90.0	89.7	88.5	90.6	90.2	88.9	91.2	91.8	90.6	93.5
62	89.1	88.6	89.5	89.2	88.2	90.2	89.8	88.6	90.7	90.3	89.0	91.3	91.9	90.7	93.6
63	89.2	88.7	89.7	89.3	88.4	90.3	89.9	88.8	90.8	90.4	89.2	91.5	92.1	90.9	93.8
64	89.3	88.8	89.8	89.4	88.5	90.4	90.0	88.9	91.0	90.6	89.4	91.6	92.3	91.1	94.0
65	89.5	89.0	90.0	89.4	88.6	90.6	90.1	89.1	91.1	90.7	89.6	91.8	92.5	91.3	94.2
66	89.6	89.1	90.1	89.5	88.8	90.7	90.2	89.2	91.3	90.9	89.8	91.9	92.7	91.6	94.4
67	89.7	89.3	90.2	89.6	88.9	90.9	90.3	89.4	91.4	91.1	90.0	92.1	92.9	91.8	94.6
68	89.9	89.4	90.4	89.7	89.1	91.0	90.4	89.6	91.6	91.3	90.2	92.2	93.2	92.1	94.8
69	89.9	89.5	90.4	89.8	89.2	91.1	90.6	89.8	91.7	91.5	90.4	92.3	93.5	92.4	94.9
70	90.0	89.6	90.5	89.9	89.4	91.2	90.7	89.9	91.8	91.8	90.6	92.4	93.8	92.7	95.1
71	90.1	89.8	90.6	90.0	89.5	91.3	90.8	90.1	91.9	92.0	90.9	92.6	94.2	93.0	95.2
72	90.3	89.9	90.7	90.1	89.7	91.4	91.0	90.3	92.0	92.3	91.1	92.7	94.6	93.3	95.4
73	90.4	90.0	90.9	90.2	89.8	91.5	91.1	90.4	92.1	92.5	91.2	92.8	95.0	93.5	95.5
74	90.5	90.1	91.0	90.3	89.8	91.6	91.2	90.5	92.3	92.8	91.3	92.9	95.5	93.6	95.7
75	90.7	90.2	91.0	90.4	89.9	91.7	91.4	90.5	92.4	93.0	91.4	93.0	96.0	93.7	95.8
76	90.8	90.3	91.1	90.4	90.0	91.8	91.3	90.6	92.5	93.0	91.5	93.1	96.0	93.9	95.9
77	90.8	90.4	91.2	90.5	90.0	91.9	91.3	90.6	92.5	92.9	91.5	93.2	95.9	94.0	96.0
78	90.9	90.5	91.2	90.5	90.1	92.0	91.2	90.7	92.6	92.8	91.6	93.3	95.9	94.1	96.1
79	91.0	90.5	91.3	90.5	90.1	92.0	91.2	90.7	92.7	92.7	91.6	93.4	95.8	94.1	96.1
80	91.1	90.6	91.4	90.6	90.1	92.1	91.1	90.6	92.7	92.7	91.6	93.4	95.7	94.1	96.2
81	91.2	90.6	91.5	90.6	90.1	92.2	91.1	90.6	92.8	92.6	91.5	93.5	95.7	94.0	96.3
82	91.4	90.7	91.5	90.6	90.2	92.3	91.0	90.6	92.9	92.5	91.3	93.6	95.6	94.0	96.4
83	91.5	90.8	91.6	90.7	90.2	92.3	91.0	90.6	93.0	92.4	91.5	93.6	95.6	94.0	96.4
84	91.6	90.8	91.7	90.7	90.2	92.4	91.0	90.6	93.0	92.4	91.5	93.7	95.6	94.0	96.5
85	91.7	90.9	91.7	90.8	90.2	92.5	91.0	90.6	93.1	92.3	91.4	93.8	95.6	94.0	96.6
86	91.8	91.0	91.8	90.9	90.2	92.5	91.0	90.6	93.1	92.3	91.4	93.8	95.5	94.0	96.6
87	91.9	91.0	91.8	90.9	90.3	92.6	91.0	90.6	93.2	92.2	91.4	93.9	95.5	94.0	96.7
88	92.0	91.1	91.9	91.0	90.3	92.6	91.0	90.6	93.3	92.2	91.5	94.0	95.5	94.0	96.7
89	92.1	91.2	92.0	91.0	90.4	92.7	91.0	90.6	93.3	92.2	91.5	94.0	95.6	94.1	96.8
90	92.2	91.3	92.0	91.1	90.4	92.8	91.0	90.6	93.4	92.2	91.5	94.1	95.6	94.1	96.9
91	92.3	91.3	92.1	91.2	90.5	92.8	91.0	90.7	93.5	92.1	91.5	94.2	95.6	94.2	97.0
92	92.4	91.4	92.2	91.3	90.5	92.9	91.1	90.7	93.5	92.1	91.6	94.2	95.6	94.2	97.0
93	92.6	91.5	92.3	91.3	90.6	93.0	91.1	90.8	93.6	92.1	91.6	94.3	95.7	94.3	97.1
94	92.7	91.6	92.3	91.4	90.7	93.1	91.1	90.8	93.7	92.2	91.6	94.4	95.8	94.4	97.2
95	92.7	91.7	92.4	91.5	90.8	93.1	91.2	90.9	93.8	92.2	91.7	94.5	95.8	94.4	97.3
96	92.8	91.8	92.5	91.6	90.8	93.2	91.2	91.0	93.8	92.2	91.8	94.6	95.9	94.5	97.4
97	92.9	91.9	92.5	91.7	90.9	93.3	91.3	91.0	93.9	92.2	91.8	94.6	96.0	94.6	97.5
98	93.1	92.0	92.6	91.8	91.0	93.4	91.4	91.1	94.0	92.2	91.9	94.7	96.0	94.7	97.6
99	93.2	92.1	92.7	91.9	91.1	93.5	91.4	91.2	94.1	92.3	92.0	94.8	96.2	94.9	97.7
100	93.3	92.2	92.8	92.0	91.2	93.5	91.5	91.3	94.2	92.3	92.0	94.9	96.3	95.0	97.9
101	93.4	92.3	92.9	92.1	91.3	93.6	91.6	91.4	94.3	92.4	92.1	95.0	96.4	95.1	98.0
102	93.5	92.4	92.9	92.2	91.4	93.7	91.7	91.5	94.4	92.5	92.2	95.1	96.5	95.3	98.1
103	93.6	92.5	93.0	92.3	91.5	93.8	91.8	91.6	94.5	92.5	92.3	95.2	96.7	95.4	98.2
104	93.7	92.6	93.1	92.4	91.6	93.9	91.9	91.7	94.6	92.6	92.4	95.3	96.8	95.5	98.4
105	93.8	92.7	93.2	92.5	91.8	94.0	92.0	91.8	94.7	92.7	92.5	95.4	97.0	95.7	98.5
106	93.9	92.8	93.3	92.6	91.9	94.0	92.1	91.9	94.7	92.8	92.6	95.5	97.2	95.8	98.6
107	94.0	92.9	93.3	92.8	92.0	94.1	92.2	92.0	94.8	92.9	92.7	95.6	97.3	96.0	98.7
108	94.1	93.0	93.4	92.9	92.1	94.2	92.3	92.1	94.9	93.0	92.8	95.7	97.5	96.1	98.8
109	94.2	93.1	93.5	93.0	92.2	94.3	92.5	92.2	95.0	93.1	92.9	95.7	97.7	96.3	98.9
110	94.3	93.2	93.5	93.1	92.4	94.3	92.6	92.4	95.0	93.2	93.0	95.8	98.0	96.5	99.0
111	94.5	93.3	93.6	93.3	92.5	94.4	92.7	92.4	95.1	93.4	93.1	95.9	98.2	96.5	99.1
112	94.5	93.4	93.7	93.4	92.5	94.5	92.9	92.5	95.2	93.5	93.2	96.0	98.4	96.6	99.2
113	94.6	93.5	93.7	93.5	92.6	94.5	93.0	92.6	95.3	93.6	93.2	96.0	98.7	96.7	99.3
114	94.7	93.6	93.8	93.6	92.7	94.6	93.1	92.7	95.3	93.7	93.3	96.1	98.6	96.8	99.4
115	94.8	93.7	93.8	93.7	92.8	94.7	93.1	92.8	95.4	93.7	93.4	96.2	98.5	96.8	99.4
116	94.9	93.8	93.9	93.8	92.9	94.7	93.2	92.9	95.4	93.7	93.4	96.2	98.5	96.9	99.5
117	95.0	93.9	93.9	93.9	93.0	94.8	93.3	92.9	95.5	93.8	93.3	96.3	98.5	96.7	99.5
118	95.1	93.9	94.0	93.9	93.1	94.8	93.3	93.0	95.5	93.6	93.5	96.3	98.5	96.9	99.6
119	95.2	94.0	94.1	94.0	93.1	94.8	93.4	93.0	95.4	93.8	93.5	96.3	98.5	96.9	99.7
120	95.3	94.1	94.1	94.1	93.2	94.9	93.5	93.1	95.6	93.7	93.6	96.4	98.5	96.9	99.7

Mile	315 Hz			630 Hz			900 Hz			1250 Hz			1600 Hz		
	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep	In	Cross	Deep
1	68.0	62.7	64.8	68.0	62.7	64.9	68.1	62.8	65.0	68.3	62.9	65.0	68.4	62.9	65.1
2	71.8	69.1	71.9	71.9	69.2	72.2	72.2	69.4	72.3	72.5	69.6	72.4	72.8	69.8	72.4
3	74.4	74.4	74.5	74.5	74.5	74.9	74.9	74.9	75.1	75.4	75.4	75.2	75.7	75.7	75.3
4	76.5	76.5	76.8	76.7	76.7	77.5	77.2	77.1	77.7	77.7	77.7	77.8	78.1	78.1	77.9
5	78.2	78.2	79.2	78.5	78.5	80.1	79.1	79.1	80.4	79.7	79.7	80.5	80.1	80.1	80.4
6	79.8	79.8	81.6	80.2	80.2	83.0	80.9	80.9	83.4	81.5	81.5	83.3	81.8	81.8	83.0
7	81.2	81.2	84.3	81.7	81.7	86.6	82.5	82.5	87.1	83.1	83.1	86.5	83.3	83.3	85.7
8	82.5	82.5	85.5	83.1	83.1	88.1	84.0	84.0	88.7	84.5	84.5	87.9	84.5	84.5	86.7
9	83.5	83.5	85.9	84.4	84.4	89.0	85.4	85.4	89.6	85.8	85.8	88.6	85.6	85.6	87.2
10	84.1	84.0	85.8	85.6	85.6	89.6	86.7	86.6	90.3	86.9	86.8	89.1	86.4	86.3	87.6
11	84.5	84.3	85.7	86.7	86.6	90.2	87.8	87.7	90.9	87.9	87.8	89.5	87.1	87.0	87.9
12	84.8	84.6	85.6	87.7	87.5	90.5	88.9	88.7	91.4	88.7	88.5	89.9	87.7	87.5	88.2
13	85.0	84.7	85.4	88.2	87.9	90.2	89.8	89.6	91.9	89.5	89.2	90.3	88.2	87.9	88.4
14	85.2	84.7	85.3	88.5	88.0	89.7	90.7	90.4	92.4	90.1	89.7	90.7	88.7	88.2	88.7
15	85.2	84.6	85.2	88.6	88.0	89.2	91.5	91.1	92.5	90.7	90.2	91.0	89.1	88.5	89.0
16	85.3	84.6	85.1	88.6	87.9	88.8	91.9	91.0	92.1	91.2	90.5	91.1	89.4	88.8	89.2
17	85.3	84.5	85.0	88.6	87.6	88.4	91.8	90.7	91.5	91.4	90.5	91.0	89.7	89.0	89.5
18	85.3	84.3	84.9	88.4	87.3	88.1	91.6	90.3	91.0	91.4	90.3	90.9	90.1	89.3	89.8
19	85.3	84.2	84.9	88.3	87.0	87.8	91.3	89.8	90.5	91.4	90.2	90.8	90.4	89.5	90.2
20	85.2	84.1	84.9	88.2	86.7	87.6	91.0	89.4	90.2	91.4	90.0	90.8	90.7	89.7	90.5
21	85.2	83.9	85.0	88.0	86.5	87.6	90.8	89.0	90.0	91.4	89.9	90.9	91.0	89.9	90.9
22	85.2	83.8	85.2	87.9	86.2	87.6	90.6	88.6	89.9	91.4	89.7	91.1	91.3	90.1	91.4
23	85.2	83.7	85.4	87.8	86.0	87.8	90.4	88.3	90.0	91.4	89.7	91.4	91.6	90.3	91.9
24	85.2	83.7	85.7	87.7	85.9	88.0	90.1	88.1	90.2	91.5	89.7	91.8	91.9	90.5	92.5
25	85.3	83.7	86.1	87.6	85.8	88.3	89.9	88.0	90.5	91.5	89.8	92.2	92.2	90.8	93.1
26	85.3	83.8	86.5	87.5	85.8	88.8	89.8	88.0	90.9	91.6	89.9	92.8	92.6	91.2	93.8
27	85.4	83.9	87.0	87.5	86.0	89.3	89.7	88.1	91.5	91.7	90.2	93.5	93.0	91.6	94.5
28	85.5	84.2	87.5	87.6	86.2	89.9	89.7	88.3	92.1	92.0	90.6	94.2	93.4	92.1	95.3
29	85.8	84.5	88.1	87.8	86.6	90.7	89.9	88.7	92.9	92.3	91.1	95.0	93.9	92.6	96.1
30	86.1	85.0	88.8	88.1	87.1	91.5	90.1	89.2	93.8	92.7	91.7	96.0	94.4	93.3	96.9
31	86.4	85.6	89.3	88.5	87.7	92.2	90.5	89.9	94.6	93.2	92.5	96.8	95.1	94.1	97.7
32	86.9	86.3	89.7	89.0	88.6	92.8	91.1	90.8	95.3	93.9	93.4	97.6	95.8	95.0	98.4
33	87.6	87.1	90.2	89.7	89.6	93.4	91.8	91.9	96.0	94.8	94.5	98.4	96.7	96.1	99.1
34	88.4	88.1	90.7	90.8	90.8	94.1	92.9	93.3	96.9	95.9	95.9	99.3	97.7	97.3	99.8
35	89.5	89.1	91.2	92.1	92.1	94.9	94.4	94.7	97.9	97.4	97.3	100.2	99.0	98.5	100.6
36	91.0	89.6	91.6	94.2	92.8	95.8	96.8	95.6	99.1	99.6	98.2	101.2	100.7	99.0	101.4
37	93.0	90.1	91.9	97.9	93.7	96.3	101.5	96.7	99.9	103.5	99.2	101.9	102.9	100.1	102.0
38	94.0	90.7	92.2	100.6	94.7	96.8	106.8	98.0	100.7	106.5	100.4	102.6	104.2	101.0	102.6
39	93.8	91.3	92.4	100.3	95.8	97.3	106.3	99.6	101.5	106.4	101.7	103.3	104.4	102.0	103.2
40	93.7	91.9	92.5	99.9	97.1	97.4	105.8	101.8	101.7	106.2	103.4	103.6	104.6	103.0	103.6
41	93.6	92.1	92.5	99.6	97.6	97.5	105.3	102.9	102.0	106.1	104.2	103.9	104.8	103.7	104.0
42	93.4	91.9	92.6	99.3	97.3	97.5	104.9	102.4	102.1	105.9	104.0	104.2	105.0	103.8	104.4
43	93.3	91.8	92.7	99.0	96.9	97.6	104.5	101.9	102.3	105.8	103.9	104.5	105.2	104.0	104.8
44	93.2	91.6	92.7	98.8	96.6	97.7	104.2	101.5	102.4	105.7	103.7	104.7	105.4	104.1	105.2
45	93.1	91.4	92.8	98.5	96.3	97.6	103.8	101.1	102.4	105.6	103.5	104.9	105.6	104.3	105.6
46	93.0	91.3	92.8	98.3	96.0	97.5	103.5	100.7	102.2	105.6	103.4	105.0	105.8	104.4	105.9
47	92.9	91.2	92.8	98.1	95.7	97.4	103.2	100.3	102.0	105.5	103.3	105.0	106.0	104.6	106.2
48	92.8	91.0	92.8	97.8	95.5	97.4	102.8	100.1	101.9	105.4	103.3	105.1	106.2	104.8	106.5
49	92.7	91.0	92.9	97.6	95.3	97.4	102.4	99.8	101.9	105.3	103.2	105.3	106.4	105.0	106.8
50	92.6	90.9	92.9	97.3	95.2	97.4	102.1	99.6	101.8	105.0	103.2	105.4	106.6	105.2	107.2
51	92.5	90.8	93.0	97.1	95.1	97.5	101.8	99.5	101.9	105.2	103.3	105.6	106.9	105.4	107.5
52	92.4	90.8	93.1	96.9	95.0	97.5	101.5	99.4	101.9	105.2	103.3	105.8	107.1	105.6	107.9
53	92.4	90.9	93.2	96.8	94.9	97.7	101.2	99.3	102.0	105.2	103.4	106.1	107.4	105.9	108.3
54	92.4	90.8	93.3	96.6	94.9	97.8	101.0	99.2	102.2	105.2	103.5	106.2	107.5	106.1	108.7
55	92.3	90.8	73.5	95.5	94.9	97.9	100.9	99.2	102.3	105.2	103.6	106.4	107.8	106.4	109.0

TABLE A-2
(Continued)

56	92.3	90.8	93.6	96.5	94.9	98.1	100.7	99.2	102.5	105.3	103.7	106.9	108.2	106.7	109.5
57	92.4	90.9	93.8	96.4	95.0	98.3	100.6	99.3	102.7	105.4	103.9	107.2	108.5	107.0	109.9
58	92.4	91.0	93.9	96.4	95.1	98.5	100.6	99.4	103.0	105.5	104.1	107.6	108.8	107.4	110.3
59	92.4	91.1	94.1	96.4	95.2	98.7	100.6	99.5	103.2	105.6	104.4	107.9	109.1	107.7	110.7
60	92.5	91.2	94.3	96.5	95.3	99.0	100.6	99.7	103.5	105.8	104.7	108.3	109.5	108.1	111.2
61	92.6	91.4	94.5	96.5	95.5	99.2	100.7	99.9	103.8	106.0	105.0	108.7	109.8	108.5	111.6
62	92.7	91.5	94.7	96.7	95.8	99.5	100.8	100.2	104.2	106.3	105.3	109.1	110.2	108.9	112.1
63	92.9	91.7	94.9	96.8	96.0	99.8	101.0	100.5	104.5	106.6	105.7	109.5	110.6	109.4	112.5
64	93.1	92.0	95.1	97.0	96.3	100.1	101.2	100.8	104.9	106.9	106.1	110.0	111.0	109.9	113.0
65	93.3	92.2	95.3	97.3	96.6	100.4	101.5	101.2	105.4	107.3	106.6	110.5	111.5	110.4	113.5
66	93.5	92.5	95.5	97.6	97.0	100.7	101.8	101.6	105.8	107.7	107.1	111.0	112.0	110.9	114.0
67	93.8	92.7	95.7	97.9	97.4	101.1	102.2	102.1	106.3	108.2	107.6	111.5	112.5	111.4	114.5
68	94.1	93.0	95.9	98.4	97.8	101.4	102.7	102.6	106.8	108.8	108.2	112.0	113.0	112.0	115.1
69	94.4	93.3	96.1	98.9	98.2	101.7	103.3	103.2	107.1	109.4	108.8	112.4	113.6	112.6	115.5
70	94.8	93.7	96.2	99.4	98.7	101.9	104.0	103.9	107.5	110.1	109.5	112.8	114.3	113.2	116.0
71	95.3	94.0	96.4	100.1	99.2	102.2	104.8	104.6	109.1	110.9	110.2	113.3	115.0	113.9	116.4
72	95.7	94.4	96.6	100.9	99.8	102.5	105.8	105.4	108.3	111.9	111.0	113.7	115.7	114.6	116.9
73	96.2	94.6	96.7	101.8	100.2	102.8	107.0	106.0	108.7	113.0	111.6	114.2	116.5	115.2	117.4
74	96.7	94.7	96.9	102.8	100.5	103.0	108.7	106.4	109.1	114.3	112.0	114.7	117.4	115.7	117.9
75	97.4	94.9	97.0	104.2	100.8	103.2	111.0	106.8	109.4	116.0	112.5	115.0	118.5	116.1	118.4
76	97.4	95.0	97.2	104.3	101.0	103.4	111.3	107.2	109.7	116.3	113.0	115.4	118.8	116.6	118.8
77	97.3	95.2	97.3	104.0	101.3	103.5	111.0	107.6	109.9	116.2	113.4	115.7	119.0	117.1	119.2
78	97.2	95.3	97.3	103.8	101.5	103.7	110.6	108.0	110.0	116.2	113.9	116.0	119.2	117.6	119.6
79	97.1	95.3	97.4	103.6	101.5	103.8	110.3	108.1	110.2	116.1	114.1	116.3	119.5	117.9	119.9
80	97.0	95.2	97.5	103.4	101.4	103.9	110.1	108.0	110.3	116.1	114.1	116.5	119.7	118.1	120.3
81	96.9	95.2	97.6	103.2	101.4	104.0	109.8	107.9	110.5	116.0	114.2	116.8	119.9	118.4	120.7
82	96.9	95.2	97.7	103.1	101.3	104.1	109.6	107.8	110.7	116.0	114.3	117.1	120.1	118.6	121.1
83	96.8	95.1	97.7	102.9	101.3	104.2	109.4	107.7	110.7	116.0	114.3	117.3	120.3	118.8	121.4
84	96.8	95.1	97.8	102.8	101.2	104.2	109.2	107.7	110.8	116.0	114.4	117.5	120.6	119.1	121.7
85	96.7	95.1	97.8	102.7	101.2	104.3	109.1	107.7	111.0	116.1	114.5	117.7	120.8	119.3	122.1
86	96.7	95.1	97.9	102.6	101.2	104.4	108.9	107.6	111.0	116.1	114.7	117.9	121.1	119.6	122.4
87	96.7	95.1	98.0	102.5	101.2	104.4	108.8	107.7	111.1	116.2	114.8	118.1	121.3	119.8	122.7
88	96.7	95.2	98.0	102.5	101.2	104.5	108.7	107.7	111.2	116.3	115.0	118.3	121.6	120.1	123.1
89	96.7	95.2	98.1	102.4	101.2	104.6	108.6	107.7	111.3	116.3	115.1	118.6	121.9	120.4	123.4
90	96.7	95.2	98.2	102.4	101.3	104.7	108.6	107.8	111.4	116.5	115.3	118.8	122.2	120.7	123.7
91	96.7	95.3	98.3	102.4	101.4	104.8	108.6	107.9	111.6	116.6	115.5	119.0	122.4	121.0	124.1
92	96.7	95.3	98.4	102.4	101.4	105.0	108.6	108.0	111.8	116.7	115.7	119.3	122.7	121.3	124.4
93	96.8	95.4	98.4	102.5	101.5	105.1	108.6	108.2	111.9	116.9	115.9	119.6	123.0	121.7	124.8
94	96.8	95.5	98.5	102.5	101.6	105.2	108.7	108.3	112.1	117.1	116.2	119.9	123.4	122.0	125.2
95	96.9	95.6	98.6	102.6	101.8	105.4	108.7	108.5	112.3	117.3	116.4	120.1	123.7	122.4	125.5
96	97.0	95.7	98.7	102.7	101.9	105.5	108.8	108.7	112.5	117.5	116.7	120.4	124.0	122.7	125.9
97	97.1	95.8	98.9	102.8	102.1	105.7	109.0	108.9	112.8	117.7	117.0	120.8	124.4	123.1	126.3
98	97.2	95.9	99.0	102.9	102.2	105.9	109.1	109.1	113.0	118.0	117.3	121.1	124.7	123.5	126.7
99	97.3	96.1	99.1	103.0	102.4	106.1	109.3	109.3	113.3	118.3	117.7	121.4	125.1	123.9	127.1
100	97.4	96.2	99.2	103.2	102.6	106.3	109.5	109.6	113.6	118.6	118.0	121.8	125.5	124.3	127.5
101	97.5	96.3	99.4	103.4	102.9	106.5	109.8	109.9	113.9	118.9	118.4	122.1	125.9	124.7	127.9
102	97.7	96.5	99.5	103.6	103.1	106.8	110.1	110.2	114.2	119.3	118.8	122.5	126.3	125.1	128.3
103	97.8	96.6	99.7	103.9	103.3	106.9	110.4	110.5	114.5	119.7	119.1	122.9	126.7	125.5	128.8
104	98.0	96.8	99.8	104.1	103.6	107.2	110.7	110.9	114.8	120.1	119.5	123.3	127.1	126.0	129.2
105	98.2	97.0	100.0	104.4	103.8	107.4	111.1	111.3	115.2	120.5	120.0	123.7	127.6	126.4	129.7
106	98.4	97.1	100.1	104.8	104.1	107.6	111.6	111.6	115.5	121.0	120.4	124.1	128.1	126.9	130.1
107	98.6	97.3	100.2	105.1	104.4	107.8	112.1	112.1	115.8	121.5	120.9	124.4	128.6	127.4	130.5
108	98.8	97.5	100.3	105.5	104.7	108.0	112.6	112.6	116.1	122.1	121.4	124.8	129.1	127.9	130.9
109	99.1	97.7	100.4	105.9	105.0	108.2	113.2	112.9	116.3	122.7	121.9	125.2	129.7	128.4	131.3
110	99.3	97.8	100.5	106.4	105.4	108.4	113.9	113.4	116.7	123.3	122.4	125.6	130.3	129.0	131.8
111	99.6	97.9	100.7	106.9	105.5	108.6	114.7	113.7	117.0	124.1	122.9	126.0	130.9	129.4	132.2
112	99.9	98.0	100.8	107.4	105.7	108.8	115.5	113.9	117.2	124.9	123.1	126.3	131.6	129.8	132.6
113	100.2	98.1	100.9	108.0	105.8	108.9	116.5	114.2	117.4	125.8	123.4	126.6	132.3	130.2	133.0
114	100.1	98.2	100.9	107.9	106.0	109.1	116.3	114.4	117.6	125.8	123.9	126.7	132.5	130.6	133.4
115	100.1	98.3	101.0	107.8	106.1	109.2	116.2	114.7	117.8	125.8	124.1	127.2	132.7	131.0	133.7
116	100.0	98.4	101.1	107.7	106.3	109.3	116.0	114.8	117.9	125.9	124.6	127.4	133.2	131.4	134.4
117	100.0	98.3	101.1	107.6	106.3	109.5	115.9	114.9	118.1	125.9	124.5	127.7	133.2	131.7	134.4
118	100.0	98.3	101.2	107.5	106.3	109.5	115.8	114.9	118.2	126.0	124.7	127.9	133.4	131.9	134.8
119	99.9	98.3	101.3	107.4	106.3	109.6	115.7	114.9	118.4	126.0	124.8	128.2	133.7	132.2	135.2
120	99.9	98.4	101.3	107.4	106.3	109.7	115.6	115.0	118.5	126.1	125.0	128.4	133.9	132.4	135.5

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TABLE A-2
(Continued)

Mile	2000 Hz In	2000 Hz Cross	2000 Hz Deep	2500 Hz In	2500 Hz Cross	2500 Hz Deep	3500 Hz In	3500 Hz Cross	3500 Hz Deep	5000 Hz In	5000 Hz Cross	5000 Hz Deep	10000 Hz In	10000 Hz Cross	10000 Hz Deep
1	68.6	63.0	65.1	68.8	63.1	65.2	69.2	63.3	65.3	69.9	63.7	65.6	72.2	65.3	67.0
2	73.1	70.0	72.6	73.5	70.3	72.7	74.3	70.7	73.0	75.4	71.5	73.5	79.9	75.0	76.5
3	76.2	76.2	75.5	76.8	76.8	75.7	77.9	77.9	76.1	79.5	79.5	76.9	85.7	85.7	81.3
4	78.7	78.7	78.1	79.4	79.4	78.4	80.8	80.8	78.9	82.7	82.7	80.0	90.3	90.3	85.8
5	80.8	80.8	80.7	81.6	81.6	81.0	83.1	83.1	81.7	85.3	85.3	83.1	93.9	93.9	90.3
6	82.5	82.5	83.3	83.4	83.4	83.7	85.0	85.0	84.6	87.3	87.3	86.2	96.9	96.9	94.8
7	84.0	84.0	86.1	84.9	84.9	86.5	86.5	86.5	87.5	88.9	88.9	89.4	99.6	99.6	99.4
8	85.3	85.3	87.1	86.2	86.2	87.7	87.8	87.8	88.8	90.3	90.3	90.8	102.1	102.1	102.3
9	86.4	86.4	87.7	87.3	87.2	88.2	88.9	88.8	89.5	91.5	91.4	91.8	104.6	104.5	104.6
10	87.2	87.1	88.1	88.1	88.0	88.7	89.7	89.6	90.0	92.4	92.3	92.6	106.9	106.7	106.8
11	87.9	87.7	88.4	88.7	88.5	89.1	90.4	90.2	90.5	93.3	93.1	93.3	109.1	108.9	109.0
12	88.5	88.2	88.7	89.3	89.0	89.4	91.0	90.7	91.0	94.2	93.9	94.0	111.3	111.0	111.2
13	89.0	88.6	89.0	89.8	89.5	89.8	91.6	91.2	91.5	95.0	94.6	94.8	113.5	113.2	113.3
14	89.4	89.0	89.3	90.3	89.8	90.1	92.2	91.7	91.9	95.8	95.3	95.5	115.7	115.3	115.5
15	89.8	89.3	89.6	90.7	90.2	90.5	92.7	92.2	92.4	96.6	96.0	96.2	117.9	117.4	117.6
16	90.2	89.6	89.9	91.1	90.5	90.9	93.2	92.6	92.9	97.3	96.7	97.0	120.1	119.5	119.8
17	90.6	89.8	90.3	91.5	90.8	91.2	93.8	93.0	93.4	98.1	97.4	97.8	122.3	121.6	122.0
18	90.9	90.1	90.6	91.9	91.1	91.6	94.3	93.5	94.0	98.9	98.0	98.5	124.5	123.7	124.2
19	91.2	90.3	91.0	92.3	91.4	92.1	94.8	93.9	94.5	99.6	98.7	99.4	126.7	125.8	126.4
20	91.6	90.6	91.4	92.7	91.7	92.5	95.3	94.3	95.1	100.4	99.4	100.2	128.9	127.9	128.7
21	91.9	90.8	91.9	93.1	92.0	93.1	95.8	94.7	95.8	101.2	100.0	101.1	131.1	130.0	131.0
22	92.3	91.1	92.4	93.5	92.3	93.6	96.3	95.1	96.5	101.9	100.7	102.1	133.3	132.1	133.4
23	92.6	91.3	92.9	93.9	92.6	94.2	96.9	95.6	97.2	102.7	101.4	103.0	135.5	134.2	135.8
24	93.0	91.6	93.6	94.3	93.0	94.9	97.4	96.1	98.0	103.5	102.1	104.1	137.7	136.4	138.3
25	93.3	91.9	94.2	94.7	93.3	95.6	98.0	96.6	98.9	104.3	102.9	105.2	140.0	138.6	140.8
26	93.7	92.3	94.9	95.2	93.8	96.4	98.6	97.1	99.8	105.2	103.7	106.4	142.2	140.8	143.4
27	94.2	92.8	95.7	95.7	94.3	97.2	99.2	97.8	100.7	106.0	104.6	107.6	144.5	143.1	146.0
28	94.6	93.3	96.5	96.2	94.9	98.1	99.8	98.5	101.7	106.9	105.6	108.8	146.9	145.5	148.7
29	95.2	93.9	97.4	96.8	95.6	99.0	100.6	99.3	102.7	107.9	106.7	110.1	149.3	148.0	151.4
30	95.8	94.7	98.3	97.5	96.4	100.0	101.3	100.2	103.8	108.9	107.8	111.4	151.7	150.6	154.2
31	96.5	95.5	99.1	98.2	97.2	100.8	102.2	101.2	104.8	110.1	109.1	112.7	154.3	153.3	156.9
32	97.2	96.5	99.8	99.0	98.3	101.6	103.2	102.4	105.7	111.3	110.5	113.8	156.9	156.1	159.5
33	98.2	97.6	100.5	100.0	99.4	102.4	104.3	103.7	106.7	112.6	112.1	115.0	159.7	159.1	162.1
34	99.2	98.8	101.3	101.2	100.7	103.2	105.5	105.1	107.6	114.2	113.8	116.2	162.6	162.2	164.7
35	100.6	100.1	102.1	102.5	102.0	104.1	107.1	106.5	108.6	115.9	115.4	117.5	165.8	165.3	167.4
36	102.3	100.9	103.0	104.3	102.9	105.0	108.9	107.6	109.6	118.1	116.7	118.8	169.4	168.0	170.1
37	104.5	101.8	103.6	106.6	103.8	105.7	111.4	108.6	110.5	120.8	118.0	119.9	173.5	170.8	172.6
38	105.9	102.7	104.3	108.0	104.8	106.4	112.9	109.7	111.3	122.6	119.4	120.9	176.8	173.6	175.1
39	106.1	103.7	104.9	108.3	105.9	107.1	113.3	110.9	112.1	123.2	120.8	122.0	178.8	176.4	177.6
40	106.3	104.8	105.3	108.6	107.1	107.6	113.8	112.2	112.7	123.9	122.4	122.9	180.9	179.4	179.9
41	106.6	105.5	105.8	108.9	107.8	108.1	114.2	113.1	113.4	124.6	123.5	123.8	183.1	182.0	182.2
42	106.8	105.7	106.2	109.2	108.0	108.6	114.6	113.5	114.0	125.3	124.1	124.7	185.1	184.0	184.6
43	107.1	105.9	106.6	109.5	108.3	109.1	115.0	113.8	114.7	125.9	124.8	125.6	187.2	186.1	186.9
44	107.3	106.1	107.2	109.8	108.5	109.6	115.5	114.2	115.3	126.6	125.4	126.5	189.4	188.1	189.2
45	107.6	106.3	107.6	110.1	108.8	110.1	115.9	114.6	115.9	127.3	126.0	127.4	191.5	190.2	191.5
46	107.8	106.5	107.9	110.4	109.1	110.5	116.3	115.0	116.4	128.0	126.7	128.1	193.6	192.3	193.7
47	108.1	106.7	108.3	110.7	109.3	110.9	116.8	115.4	117.0	128.7	127.3	128.9	195.7	194.3	195.9
48	108.3	106.9	108.6	111.0	109.6	111.3	117.2	115.8	117.5	129.4	128.0	129.7	197.8	196.4	198.1
49	108.6	107.2	109.0	111.3	109.9	111.8	117.7	116.2	118.1	130.1	128.7	130.5	200.0	198.5	200.4
50	108.9	107.4	109.4	111.7	110.2	112.2	118.1	116.7	118.7	130.8	129.4	131.4	202.1	200.7	202.6
51	109.1	107.7	109.8	112.0	110.5	112.7	118.6	117.1	119.2	131.5	130.1	132.2	204.2	202.8	204.9
52	109.4	107.9	110.2	112.3	110.9	113.1	119.0	117.6	119.6	132.2	130.8	132.7	206.4	204.9	207.2

53	109 7	108 2	110 6	112 7	111 2	113.6	119 5	118.1	120 4	133.0	131 5	133.9	208.5	207 1	209 5
54	110 0	108.5	111.0	113.0	111.6	114.1	120.0	118.5	121.0	133 7	132.3	134 8	210.7	209 2	211.7
55	110 3	108 9	111.5	113 4	111 9	114.6	120.5	119 0	121 7	134 5	133.0	135 6	212.9	211.4	214 0
56	110.7	109.2	111.9	113 8	112.3	115.1	121.0	119 6	122.3	135.2	133 8	136 5	215.1	213.6	216.4
57	111.0	109 6	112.4	114 2	112.8	115.6	121.6	120.1	122.9	136 0	134.6	137.4	217 3	215.8	218.7
58	111 3	109 9	112.9	114.6	113.2	116.1	122.1	120.7	123.6	136 8	135.4	138 3	219.5	218.1	220.0
59	111.7	110.3	113.3	115.0	113.6	116 6	122.6	121.3	124 3	137.6	136 2	139 2	220 0	220 0	220.0
60	112.1	110.8	113.8	115 5	114.1	117 2	123.2	121.9	124 9	138 5	137.1	140 2	220 0	220 0	220.0
61	112.5	111.2	114 3	115.9	114.6	117 7	123.8	122.5	125.6	139 3	138.0	141.1	220 0	220 0	220.0
62	112.9	111.7	114.8	116.4	115.2	118.3	124 4	123.2	126.3	140.2	138 9	142.0	220.0	220 0	220.0
63	113 4	112.2	115.3	116.9	115 7	118 9	125.1	123 8	127 0	141.1	139 8	143.0	220.0	220 0	220.0
64	113.9	112.7	115.9	117 5	116.3	119.5	125 7	124.6	127.7	142.0	140 8	144 0	220.0	220 0	220.0
65	114 4	113.2	116.4	118.0	116.9	120.0	126 4	125 3	128 4	142.9	141.8	144 9	220.0	220 0	220.0
66	114.9	113 8	116.9	118 6	117.5	120.6	127 1	126.0	129 2	143.9	142.8	145 9	220.0	220 0	220.0
67	115 5	114.4	117.5	119.2	118.2	121.3	127 9	126.8	129.9	144.9	143.8	146 9	220.0	220 0	220.0
68	116.0	115 0	118.1	119 9	118.8	121 9	128.6	127.6	130.7	145 9	144.9	147 9	220.0	220 0	220.0
69	116.7	115 7	118.6	120.6	119 5	122.4	129 5	128.5	131.3	147.0	146.0	148 9	220.0	220 0	220.0
70	117 4	116.3	119 1	121.3	120.3	123.0	130 3	129 3	132.0	148 1	147.1	149 8	220.0	220 0	220.0
71	118.1	117.1	119 6	122.1	121.0	123.6	131.3	130.2	132.7	149 3	148 2	150 8	220.0	220 0	220 0
72	118.9	117 8	120 1	122.9	121.9	124 2	132.2	131.1	133.5	150.5	149 4	151 7	220.0	220 0	220 0
73	119 8	118.4	120.7	123 9	122 5	124.8	133 3	132.0	134 2	151 8	150 5	152 7	220 0	220 0	220 0
74	120 7	118.9	121.2	124 9	123.1	125 3	134 4	132.7	134 9	153 2	151 4	153.7	220.0	220 0	220 0
75	121.8	119.5	121.7	126 0	123.7	125.9	135.7	133.4	135.6	154 7	152 4	154 6	220.0	220 0	220 0
76	122.2	120.0	122.2	126.5	124.3	126 4	136 3	134 1	136.2	155 6	153 4	155.5	220.0	220 0	220 0
77	122.4	120.5	122.6	126 8	124.9	126 9	136.7	134.8	136.9	156 3	154 3	156 4	220.0	220 0	220 0
78	122.7	121.1	123.0	127 1	125 5	127 4	137 1	135.5	137.5	156.9	155 3	157 3	220.0	220 0	220.0
79	122.9	121.4	123 4	127 4	125.9	127.9	137 6	136.1	138.1	157 6	156.1	158.1	220.0	220 0	220.0
80	123 2	121.7	123.8	127.7	126 2	128 2	138 0	136 5	138.7	158 3	156 8	159.0	220.0	220 0	220.0
81	123 5	121.9	124 3	128 0	126.5	128 8	138.5	136.9	139 3	159 0	157 5	159 9	220.0	220 0	220.0
82	123.7	122.2	124.7	128 4	126.8	129.3	138.9	137.4	139 9	159.8	158 2	160.7	220 0	220 0	220 0
83	124 0	122.5	125.1	128.7	127 2	129 8	139.4	137.9	140.5	160.5	158 9	161 5	220.0	220 0	220 0
84	124 3	122.8	125.5	129 0	127 5	130.2	139 9	138.3	141.2	161.2	159 7	162 3	220.0	220 0	220 0
85	124.6	123.1	125.8	129 4	127.9	130 6	140.3	138.8	141.6	161.9	160 4	163.1	220.0	220 0	220 0
86	124 9	123 4	126 2	129 7	128 2	131.0	140 8	139 3	142.1	162 7	161 2	164 0	220.0	220 0	220 0
87	125.2	123.7	126.6	130.1	128.6	131 5	141.3	139 8	142.7	163 4	161 9	164 8	220.0	220 0	220 0
88	125.5	124 0	126.9	130 4	129 0	131 9	141.8	140.3	143.2	164 1	162 7	165.6	220 0	220 0	220 0
89	125 8	124.4	127 3	130.8	129 4	132.3	142.3	140.8	143 8	164 9	163 4	166.4	220 0	220 0	220.0
90	126.1	124.7	127.7	131.2	129 8	132.8	142 8	141.4	144.4	165.7	164.2	167.2	220 0	220 0	220 0
91	126 5	125.1	128 1	131.6	130.2	133 2	143.3	141.9	145 0	166 4	165 0	168.1	220 0	220 0	220.0
92	126.8	125 4	128 5	132.0	130.6	133 7	143.9	142.5	145.6	167 2	165 8	168 9	220 0	220 0	220.0
93	127 2	125 8	128 9	132 4	131 0	134 1	144 4	143.0	146.1	168.0	166 6	169 8	220 0	220 0	220.0
94	127.5	126.2	129 3	132 8	131.5	134 6	144 9	143.6	146.7	168.8	167 5	170 6	220 0	220 0	220.0
95	127.9	126.6	129 7	133.3	131 9	135 1	145 5	144 2	147 3	169 6	168 3	171.5	220 0	220 0	220.0
96	128.3	127 0	130 2	133.7	132.4	135.6	146 0	144 8	148 0	170 4	169 1	172.3	220 0	220 0	220 0
97	128 7	127 4	130.6	134 1	132 8	136 1	146.6	145 4	148.6	171 3	170 0	173 2	220.0	220 0	220 0
98	129.1	127 8	131.0	134.6	133.3	136.5	147 2	146 0	149 2	172.1	170 9	174 1	220.0	220 0	220.0
99	129 5	128 3	131.5	135.0	133 8	137 0	147 8	146.6	149.8	172 9	171 7	175 0	220 0	220 0	220 0
100	129 9	128.7	131.9	135.5	134.3	137 6	148 4	147 2	150.5	173 8	172.6	175 9	220.0	220 0	220 0
101	130.3	129 2	132 4	136.0	134 8	138.1	149 0	147.9	151.1	174 7	173 5	176 7	220.0	220 0	220.0
102	130.8	129.6	132.9	136 5	135 4	138 6	149.7	148.5	151.8	175 5	174 4	177.7	220 0	220 0	220.0
103	131 3	130.1	133 3	137 1	135.9	139 1	150.3	149 2	152.4	176 5	175 3	178.6	220 0	220 0	220.0
104	131 7	130 6	133.8	137 6	136.4	139 7	151.0	149.9	153.1	177 4	176.3	179 5	220.0	220 0	220.0
105	132.3	131.1	134 3	138 2	137.0	140.2	151.7	150.5	153.8	178 4	177.2	180.4	220.0	220 0	220.0
106	132.8	131 6	134 8	138 7	137 6	140.7	152 4	151.2	154 4	179 3	178.2	181 3	220 0	220 0	220.0
107	133.3	132.1	135 2	139 4	138 1	141 2	153.2	152.0	155 0	180 3	179 1	182.2	220 0	220 0	220.0
108	133 9	132 7	135 7	140 0	138.7	141.8	153 9	152.7	155.7	181 3	180 1	183 1	220 0	220 0	220.0
109	134 5	133 2	136 1	140 6	139 4	142.3	154.7	153 4	156 3	182.4	181.1	184 0	220.0	220 0	220.0
110	135 2	133 8	136.6	141 3	140.0	142 8	155 5	154 2	157 0	183 5	182.1	184 9	220 0	220 0	220 0
111	135 8	134 3	137 1	142 1	140 6	143 3	156 4	154 8	157 7	184 6	183 0	185 9	220 0	220 0	220 0
112	136 5	134 7	137 6	142.8	141 0	143 8	157 3	155 5	158 3	185 7	183 9	186 7	220.0	220 0	220 0
113	137 2	135 2	138 0	143 5	141 5	144 3	158 2	156 1	159 3	**196.8**	**194.8**	**197.6**	**220.0**	**220 0**	**220.0**
114	137 5	135 6	138 4	143 9	142.0	144 8	158.7	156.7	159.5	187 6	185 7	188 5	220.0	220 0	220 0
115	137 8	136.1	138 8	144 3	142 5	145 3	159 1	157.4	160.1	188 3	186 6	189 3	220.0	220 0	220 0
116	138 1	136 5	139 2	144 6	143.0	145 7	159 6	158.0	160.7	189 0	187 5	190 2	220 0	220 0	220.0
117	138 4	136 8	139 6	144.9	143 4	146.2	160 0	158 5	161.3	189 8	188 2	191.0	220 0	220 0	220.0
118	138 7	137 1	140 0	145 3	143.8	146.6	160 5	159 0	161 9	190 5	189 0	191 8	220 0	220 0	220 0
119	138 9	137 4	140 4	145 6	144 1	147 1	161 0	159 5	162.5	191 2	189 7	192 7	220 0	220 0	220 0
120	139 2	137.7	140 8	146.0	144 5	147.6	161 5	160.0	163.0	191 9	190 4	193 5	220.0	220 0	220 0

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